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WORLD OIL

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a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **An abundant domestic supply** of readily available oil must be maintained by the U. S. at all times. The Suez crisis has again demonstrated how essential adequate oil supplies are to peaceful progress and wartime defense of both the U.S. and its allies. Once again the U.S. oil industry has been able to fulfill emergency requirements thrust on it overnight. This ability is the result of the favorable conditions under which the U.S. oil industry has been allowed to operate. The security of the country will be endangered if anything is permitted to impair the efficiency of the industry. **An Editorial: Adequate U.S. Oil Supply Essential** ..... **Page 45**

☐ **Future U. S. oil conditions** depend on how wisely the industry manages its affairs. Prospects have been greatly improved recently. However, excessive gasoline stocks are still a problem, and will grow worse until steps are taken to reduce motor fuel yields. Then the industry must make plans to adjust production and refinery operations to conditions when reopening of the Suez Canal lets Middle East oil again supply Western Europe's needs. **Page 68. Future Depends on Industry Actions** ..... **Ray L. Dudley and Warren L. Baker**

☐ **The East Texas field,** largest in the U. S., is an outstanding example of a scientific, efficient oil production operation. It is expected that up to 90 percent of the oil originally in the reservoir eventually will

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be produced. The exceptionally high recovery will be possible because of the program of re-injecting salt water from producing wells back into the producing formation. The water injection maintains the pressure in the formation, drives the oil to the wells, and keeps wells flowing. Relatively little oil is left behind in the formation. Some wells probably will still be producing 50 to 75 years from now. The field still has 20,000 wells, half of them flowing, and produces 200,000 barrels per day under proration. The great field already has produced over 3 billion barrels—more than any other field. It is expected to yield ultimately 5 to 6 billion barrels of oil. See **Page 46. Water Injection to Give East Texas High Oil Recovery**. . **L. J. Logan and Anthony Gibbon**

☐ **Many oil companies are paying more** for electric power than they need to pay. Without reducing the amount of electricity used, important savings can be made by many consumers. The savings can be made by taking full advantage of the best rates to which the users are entitled. Buying electric power is an "art." Numerous factors affect the rates paid and the amounts of the monthly and annual costs of electric service. How to make important savings on power is pointed out in the article on **Page 49. How to Stretch Your Power Dollar**. . . . . **Luther W. Davis**

☐ **This month WORLD OIL is beginning a timely series** that promises to fill a long standing need in the oil industry. Starting with the basic fundamentals of fire protection (definitions and crude characteristics), one of the nation's top authorities in fire fighting and fire prevention will cover every aspect of this vitally important field. Future articles will include new methods of preventing fires, new methods of extinguishment and control, safe handling and storage of crude, effective safety and fire prevention programs, to name a few. Clip this series, it will make an excellent fire protection manual for any company. Turn to **Page 52. How Oil Burns—and Why**. . . . . **J. L. Risinger**

☐ **Recent developments** have indicated that the most dependable way of moving Middle East oil to consumers is by tanker. In the future, tankers should be relied upon as the primary method of transporting that oil. Pipe lines and canals as means of moving the oil are not dependable. Oil moved through them can be too easily stopped through political and military developments. Turn to **Page 64. Tankers Best for Transporting Middle East Oil**. . . . . **Theodore Wild**

EXPLORATION ARTICLES

☐ **Seismic, gravity and subsurface surveys** are credited for the unusually high discovery rate, which is somewhat higher than the national average, in southeastern Saskatchewan. For a review of this recent field development, see **High Success Rate Spurs Saskatchewan Development.** . . . . . **Page 75**

☐ **The fabulous Pembina field,** which accounts for at least one fourth of Alberta's total production, continues to expand. Further field development is indicated by the spotted occurrence of Viking and Mississippian production. For an up-to-the-minute report on this field, see **Pembina Field Still Expanding. Page 76**

☐ **Are Mid-Continent oil operators overlooking a bet?** The Abilene anticline offers excellent exploration prospects for the careful driller who knows how to cope with the area's peculiar problems. In the article beginning on **Page 77,** the author advances arguments to attract operators seeking new reservoirs in shallow beds. **Abilene Anticline Indicates Exploration Potential**. . . . . **Claude W. Shenkel, Jr.**

☐ **The importance of turbidity or density currents** in the evolution of many submarine canyons is discussed in the article beginning on **Page 81. Turbidity Current and Its Importance in Erosion and Deposition of Sediments**. . . . . **V. G. Gabriel**

☐ **A detailed study of micro-fossils,** taken from a number of Texas Panhandle wells, was conducted to develop a stratigraphic column of the area. In turn, the column has been subdivided into 14 time-

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THIS MONTH . . .

stratigraphic units for more intricate investigation. Part 1 of the article covering this research starts on **Page 82. Texas Panhandle Paleogeology**.....**Robert Roth**

DRILLING ARTICLES

☐ **To promote a better understanding** of the tools and techniques that are required to recover stuck pipe or junk from the hole this series of six articles describes the evolution of these tools and their operation. For full details on the design, operation, advantages and limitations of jars, read the first of this series starting on **Page 89. Fishing Tools and Techniques (Part I: Jars)**.....**Weldon L. Medders**

☐ **It is desirable to determine the severity of hole curvature** as early as possible. If single shot surveys are run then a change in either the inclination or direction, or both, will permit the operator to determine the severity of hole curvature with charts. Turn to **Page 95. How Severe Is That Dogleg? Arthur Lubinski**

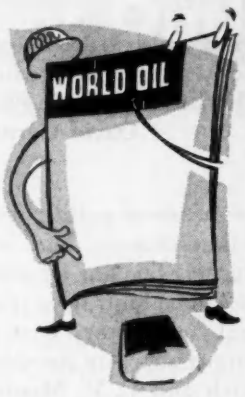
☐ **Offshore submersible drilling platforms** don't capsize every day, but when they do there are a few million dollars at stake. To see how engineers salvaged the SEDCO #8 when it capsized and some of the main points to be considered read **An Engineering Feat—Righting a Capsized Drilling Barge**....**Page 106**

☐ **Diesel electric rigs** incorporate an infinitely variable speed changer, flexibility in equipment arrangement, elimination of most alignment problems and decreased maintenance costs. To understand more fully why these systems are increasing in popularity, especially on the large rigs, turn to **Page 110** and read **Diesel Electric Transmission in Drilling Rigs**.....**R. B. Bobisuthi**

☐ **Many variables contribute** to the progress the bit makes through a formation, i.e., weight, rotary speed, type and weight of drilling fluid, type of bit, etc. In order to develop a relationship between two or more of these variables the AAODC is conducting tests on **How Weight-Speed Affects Penetration Rates. Page 120**

PRODUCTION ARTICLES

☐ **Is your pumping unit in balance?** Various methods of counterbalancing are in use today, yet it is estimated that 70 to 80 percent of all pumping units are out of balance. With maintenance costs mounting, it could pay you to compare the method you use with others in use. You'll find this comparison in an article starting on **Page 123. Evaluation of Counterbalance Methods**.....**Kenneth N. Mills**



We've Taken Off Some Weight

Several months ago we put WORLD OIL on the scales and found he was getting a little thick around the middle. We found too that he was getting a little stiff in the joints, making it a little difficult to keep open to the page being read, particularly in the middle of the book.

What should be done? Cut down on the total number of pages? No indeed. Editorial and advertising content for 1957 must be more appetizing than ever. For such a gourmet as WORLD OIL to forego any of these morsels was out of the question.

The chief culprit seemed to be the large number of stiff heavy paper insert pages. So the "reducing" plan which first showed results in your January issue was put into effect. Editorial section covers are no longer printed on stiffer and heavier paper than regular pages. With the section covers on lighter paper we are now "trimmed" down for easier reading without sacrificing any of our top-notch contents.

We are still sectionalized for your convenience . . . Current Outlook . . . Exploration . . . Drilling . . . Production . . . and International. Each division is indicated on the first editorial page of that section, and the sections of all other pages are marked at the bottom of each page.

You may have noticed the results of our "reducing" plan in the first two issues of this year. We just thought you'd like to know how we went about it.

The Editors

☐ **Field checks for equipment** defects are being carried out successfully by using high frequency sound waves. Casing, tubing, engine parts, storage tanks and other pieces of equpiment can be checked at the well effectively and economically. Turn to **Page 128. Ultrasonic Inspection Moves to the Field**...**Dwight J. Evans**

☐ **The procedure for solving successive flow rate** or flow-after-flow production problems in natural gas reservoirs using the Van Everdingen and Hurst solutions is presented and illustrated with a typical problem. Such calculations are of interest in natural

Turn the Page ▸

THIS MONTH . . .

gas reservoir engineering problems involving the conventional back pressure test and typical field production scheduling. Turn to **Page 133. Unsteady State Flow in Gas Reservoirs**. . . . . **David Cornell**

☐ **Gas jet compressors** as a means of putting low-pressure gas into intermediate-pressure lines are rating a closer look by gas producers. The gas jet compressor has no moving parts and can be built for a fraction of the cost of a conventional compressor. Turn to **Page 136** for details. **Gas Jet Compressors Are Arousing Interest**. . . . . **Frank H. Dotterweich and C. V. Mooney**

☐ **Here at last is a clear, concise and complete picture** of the part chemical additives play in formation fracturing. What additives are available? How do they perform? When should each be used? Every production man should read, understand and keep this article for future reference. See **Page 148. Chemical Additives Improving Fracturing**. . . . . **A. W. Coulter**

INTERNATIONAL ARTICLES

☐ **Spiraling domestic consumption** and a favorable market created by the crisis surrounding the Suez canal have spurred Mexico to plan an unprecedented industry operating level for this year. The drilling program outlined by Petroleos Mexicanos, the government oil monopoly, calls for the completion of 410 wells. **Mexico Spurs Oil Operations to Fill Part of 'Suez Slack'.** . . . . . **Page 161**

☐ **The proposed Trans-Europe pipe line**—the most imaginative project of its type yet conceived on the Continent—would reach from the North Sea to Marseille, France, with lateral lines serving Switzerland, Luxemburg and Holland. For an analysis of the position of both the German and French governments as well as the oil companies with regard to the proposed pipe line and the suggested Moselle river canal, read **Trans-Europe Pipe Line Economics Weighed. Page 164**

☐ **Israel has stepped up drilling and production efforts** to offset the stoppage of crude oil supply from the Middle East. For details on both programs and a late evaluation of the nation's single oil field, see **Israel Steps Up Drilling and Production**. . . . **Page 166**

☐ **How Much Help From Venezuela?** H. W. Haight, president of Creole Petroleum Corp., one of Venezuela's major oil companies, says in an interview that only a small amount of the oil which Europe needs as a result of the Middle East crisis can come from Venezuela. For his reasons, see **Page 169. Venezuela Can Supply Only a Small Part of Europe's Needs.** . . . . . **Anthony Gibbon**

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Looking Ahead . . .

Middle East Outlook Brightens . . . It is now hoped that oil movement from the Middle East to Europe can be largely restored within a few months. By the middle of May or sooner the movement may be back close to normal, according to some estimates. Lighter tankers will be able to go through the Suez Canal in a short time, possibly in March, it is predicted. The canal will be cleared for heavier tankers by May, according to some estimates.

The pipe lines from Iraq to the Mediterranean could be moving some oil within a few weeks after repairs start, it is believed. The initial limited movement of about 200,000 barrels daily would be achieved through bypassing damaged pump stations. To restore previous capacity, however, would involve rehabilitation of the stations. That would require many months. In late January, the start of repairs to the pipe line was being delayed by the Syrian government.

Under the assumption that Syria would soon allow work on the pipe lines to begin, it was estimated that by April 1, as much as 500,000 barrels of oil a day could be moved through the canal and the pipe lines.

•

Western Hemisphere Must Re-Adjust . . . In anticipation of the resumption of normal movement of Middle East oil to Europe, there is much anxiety over a possible painful readjustment for the oil industry of the Western Hemisphere.

The temporary demand for Western Hemisphere oil by Europeans will come to an end in the spring. That decrease in demand will be thrown in on top of the usual spring-summer seasonal shrinkage of the market for petroleum. In that period the requirements for distillate fuel oil will contract greatly, and gasoline consumption will not have experienced the vacation season pickup.

The temporary European demand has been concentrated especially on crude oil and to limited extent on fuel oils. It has not included much gasoline. U. S. gasoline stocks have continued excessive.

It is now feared that prices of gasoline and other refined products may seriously weaken in coming months. If product prices should deteriorate, crude oil prices, too, would be in jeopardy.

•

Strong Competition Ahead . . . When oil begins moving normally again from the Middle East, it will become keenly competitive in the world markets. In the U. S. it will be more competitive than before. That is because of the general crude price increase of about 35 cents a barrel in the U. S. Mid-Continent and Gulf Coast in early January, 1957.

Unless Middle East crude also is increased, it will have a new price advantage of 35 cents a barrel. Even while the old U. S. postings were in effect, substantial volumes of Middle East crude were underselling U. S. supplies. Some Middle East crude was being unloaded along the Houston ship channel within view of the derricks of Gulf Coast fields.

•

Oil To Be Offered for Dollars . . . When Middle East crude is again available to sell in the U. S., there will also be a new incentive to make sales on the part of some Middle East producers. British and French interests, particularly, will have strong reason to try to sell Middle East crude to U. S. refiners. They have had to pay out scarce dollars for emergency purchase of Western Hemisphere oil. They naturally will want, if possible, to retrieve some of the dollars by selling oil in the U. S.

Continued on Page 42

LOOKING AHEAD . . .

Increased Imports Feared . . . U. S. independent operators are afraid that U. S. international oil companies also will step up their imports of Middle East crude when possible.

Encouraging increased imports, it is felt, will be the desire to improve earnings on Eastern Hemisphere investments, pressure from Middle East governments for larger production. Finally, it is speculated, Middle East producers henceforth will naturally want to produce as much as possible as soon as possible. For the troubles of the past year have emphasized the insecurity of Middle East reserves and properties.

•

Opposition to Imports Will Be Strong . . . Since Middle East crude before long will be strongly competing for U. S. markets, protests against petroleum imports are due to be heard again around the middle of this year. They probably will be louder than those of the past. For the imports will threaten to undermine the present, improved U. S. price structures, which have been long sought and finally achieved, in the absence of the plentiful supplies of imported oils.

Now the opponents of oil imports have more convincing evidence than previously in demanding restrictions on the admittance of foreign oils. They can offer the current stoppage of the movement of Middle East oil as proof that the U. S. should not depend on foreign oils.

Proposals for restriction of U. S. petroleum imports doubtless could muster much more support in the future than they could before the Suez crisis.

The future holds increases in U. S. oil imports, strong opposition to the imports, and probable new restrictions on them.

•

Active Tanker Building Scheduled . . . U. S. shipyards will build all the vessels they can for the next 5 or 6 years. A high proportion will be tankers. At beginning of 1957 the shipbuilders had orders for 65 commercial vessels, of which over three-fourths will be tankers. That means near-capacity operations for three years. In addition, 58 more tankers and other ships costing more than $700 million will be built under arrangements recently announced by the Maritime Administration.

•

Offshore Prospects Best in Louisiana . . . Exploration men watching offshore Gulf of Mexico developments are generally discouraged by Miocene sand conditions in the Continental-Shell Oil Company wildcat abandoned below 13,000 feet in mid-1956. This very important test, located 63 miles southeast of Galveston just west of the Texas-Louisiana jurisdictional line in 93 feet of water, found the Miocene sands rather poorly developed.

Though this still may represent a local condition, it looks as though good Miocene sand development simply may not extend this far westward. Louisiana's offshore prospects still look better than Texas'.

By the same token, geologists will watch with great interest how far offshore coarse-grained, highly permeable sands deposited in Miocene times by the ancestral Mississippi River extend. A facies change from coarse, permeable sand to fine-grained sand to siltstone to shale will probably become apparent as drilling, in progressively deeper water, approaches the Continental Shelf. The extent of Gulf offshore reserves will depend greatly on Miocene sand development.

•

Europe Will Speed Atomic Power Use . . . Western European countries will accelerate development of industrial use of atomic power as a result of the Middle East troubles. They have been shocked into realization they cannot afford to depend so greatly on supplies of oil coming through the Suez Canal and adjacent pipe lines. Atomic energy would be more competitive with oil moving from the Middle East around Africa than with oil coming via Suez or the pipe lines. Furthermore, much of Europe's oil use has been for industry and commerce. Atomic energy is especially well suited for generating electricity and is potentially competitive with fuel oils at utility plants.

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- ***Andrews County, West Texas***—(New well) Drilled as an extension to the Fullerton field and completed in Clearfork dolomitic limestone (6,800-7,080 feet). Well showed no production on drill stem test and little production after a 2,000-gallon acid treatment. After treatment with Acid Petrofrac using 15,000 gallons of fluid and 15,000 pounds of sand—down tubing and casing at 15 barrels per minute—well tested 419 barrels per day.

- ***Fremont County, Wyoming***—(Old well, new zone) A well in the Shelton Dome field had depleted the lower zone. Before plugging, it was decided to give the Embar lime at 6,360 feet an acid-base fracture treatment. (This zone had been acidized and plugged in 1945.) Dowell fractured the well with Acid Petrofrac, using 5,000 gallons of fluid without sand. Well then flowed 21 barrels of oil per hour.

- ***Harris County, Texas***—(New well) Completed in Yegua shaley sandstone of Rankin field. Perforated from 7,870 to 7,916 feet. Before Acid Petrofrac, well tested only a show of oil and gas. After 9,000-gallon frac treatment with 20,000 lbs. of sand and 250 gallons of temporary plug (Fixafrac*), well swabbed 50 barrels of oil per day.

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Adequate U. S. Oil Supply Essential

No new world oil trade problems have been "created" by the Suez crisis. Rather, it has crystallized into existence problems which long have threatened the Free World, and which will continue to exist after the Suez Canal is reopened to traffic. Potential dangers thrive whenever an area's crude supplies depend upon conditions which can be twisted by the whims of a single person or a small group of people. A country friendly today may become unfriendly tomorrow.

However, this crisis, and the ensuing shutdown of the canal, has served to again point up a matter which also is of primary importance to the Free World. For out of the turmoil has come a reemphasis of the undeniable importance of the American free enterprise oil industry, unfettered by government controls.

Stepping in to fill the critical gap in Western Europe's oil supply have been the U. S. and Venezuela. At recent reports, both countries were exporting to Western Europe about 1,200,000 barrels daily, as compared to only 470,000 barrels daily during 1955. Bulk of the increase has come from the U. S., which now is supplying close to 500,000 barrels per day compared with only 40,000 barrels in 1955.

This is not the first time the U. S. has had to supply emergency needs. More than likely it will not be the last time.

•

Behind the ability of the U. S. to speed to the immediate assistance of its Western Europe allies lies an oil history which dates back to 1859. From the beginning, the U. S. oil industry has set an example which far too few nations have followed.

It is a credit to the U. S. government and to the oil industry itself that domestic reserves and producing capacity have been developed sufficiently to again fill the needs of the Free World. The factors which have assisted this progress are those which are found missing in many other potentially great oil producing nations.

A free competitive enterprise business system, further enhanced by continuing favorable tax laws —including percentage depletion allowance—adequate prices, and what generally is conceded to be the best in conservation practices, has enabled the U. S. to foster an oil industry whose reserve producing strength has been able to contribute greatly to its peacetime standard of living and to contribute immeasurably to its national defense.

While oil exported from the U. S. to Western Europe has been siphoned in large part from abundant storage, production has been increased sharply also. Parts of the Gulf Coast and Mid-Continent serve as examples of what the U. S. has been able to do through accelerated production. Oklahoma, Texas and Louisiana increased their combined crude output by 300,000 barrels per day between August and the last week in 1956. Most of the increase came from Louisiana, although Texas certainly had the producing ability to enlarge its output by a much greater amount. Pipe line capacities, not producing ability, is the only factor restricting Texas' production rate.

•

It has been possible for the U. S. to do so much to alleviate the pressure on oil-short allies only because of its national business system which permits private enterprise operations. In a favorable and competitive climate, U. S. crude reserves have blossomed. Through sensible conservation practices these reserves have been produced under programs designed to prevent waste and to extract all possible oil from the reservoirs.

Any change in conditions which would impair or retard the efficiency of the U. S. oil industry would be extremely dangerous. Adequate oil supplies are essential to peaceful progress and wartime defense of both the U. S. and its allies. The U. S. must maintain an abundant domestic supply of readily available oil at all times. To do otherwise would invite disaster. The Suez crisis again points to this inescapable conclusion.

Water Injection to Give East Texas High Oil Recovery

Up to 90% of oil originally in reservoir finally may be produced. Only 30% to 40% recovery was expected prior to water injection.

Re-injection of salt water from wells back into producing formation maintains pressure, drives oil to wells, and keeps wells flowing.

Biggest U. S. field now expected to yield 5 to 6 billion barrels of oil. Some wells may be still producing 50 to 75 years from now.

In 25 years East Texas has produced over 3 billion barrels of oil—more than any other field.

By L. J. LOGAN and ANTHONY GIBBON
WORLD OIL Staff

SALT WATER re-injection and pressure maintenance will contribute greatly to the amazingly high oil recovery expected for the East Texas field.

Up to 90 percent of the oil originally in the reservoir ultimately may be recovered. Before the water injection program was started, an ultimate recovery of only 30 to 40 percent was expected.

Reservoir engineers now believe that the field finally will produce from 5 billion to 6 billion barrels of oil. Of this amount at least 600 million barrels will represent recovery made possible by the water injection program. The field is expected to be producing well into the 21st century. It may be 50 to 75 years from now before the last wells are abandoned.

For a long time yet, East Texas will continue to produce more oil each year than most fields do in a lifetime. It still has almost 20,000 wells, nearly half of them flowing. It produces over 200,000 barrels of oil daily under proration, or at the rate of almost 75 million barrels per year. In December, 1956, and January, 1957, most wells were allowed to produce 20 barrels daily for 16 days a month. Some of the flowing wells can still make their 20-barrel allowable in 20 minutes.

Now 25 years old, East Texas already has produced well over 3 billion barrels of oil—more than any other field. In its early days, before proration was effectively established to prevent waste, the field's production swelled to 1 million barrels per day and the price of its crude dropped to 10 cents a barrel. The field finally was shut down by martial law. After a series of court tests, proration at last was upheld and provided orderly, efficient production. In spite of its unprecedented past production, the great field can still give up in the future an estimated 2 billion to 3 billion barrels more.

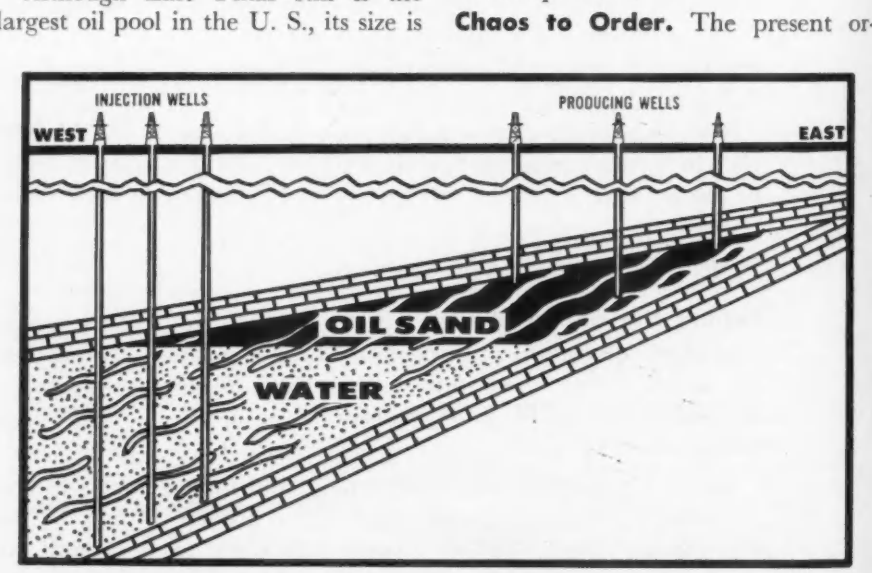
Although East Texas still is the largest oil pool in the U. S., its size is steadily shrinking. (See map.) Originally 43 miles long and from 5 to 8 miles wide, the field's productive area is narrowing as water encroaches from west to east in the producing formation, the Woodbine sand.

But because of the water injection program, relatively little oil is being left behind. Through the water injection and restriction of production by proration, the reservoir pressure is held high enough to keep wells flowing. The water level rises evenly, and oil goes out the wells in advance of it.

The oil is contained in a stratigraphic trap. It is in the porous Woodbine sandstone, which pinches out toward the east along an ancient shore line of a regional uplift. The Woodbine represents a wedge between impervious rocks below and above it. (See cross-section.) Water in the Woodbine, below the oil, rises and moves eastward as oil is withdrawn. The western limit of the field gradually moves eastward. Wells on the west produce more and more water until they finally are abandoned.

In the water injection program, salt water that is produced from wells along with oil is piped to the west, filtered, treated, and re-injected into the Woodbine below the water level. The program increases greatly the amount of oil recovery at the same time that it solves the problem of disposing of the vast amounts of salt water produced along with the oil. Before the program was started, salt water disposal had become a very serious problem.

Chaos to Order. The present or-



Water Drives Oil to Wells—Here is an east-west cross-section of the East Texas field. It shows how the salt water re-injection works. Water produced along with oil by wells toward the east is gathered and piped back to the west. It is treated there and re-injected into the producing formation. The water maintains the pressure in the reservoir, drives the oil upward and eastward to the wells, and keeps wells flowing.

derly, efficient operation of the East Texas field contrasts sharply with its hectic beginnings. Shortly after its discovery in late 1930, the big field saw uncontrolled drilling, wasteful production, and "hot oil" operations that tumbled the price of crude to 10 cents a barrel and brought martial law to the area. East Texas now is an outstanding example of how to produce an oil field, with benefit of proration, water re-injection, and pressure maintenance.

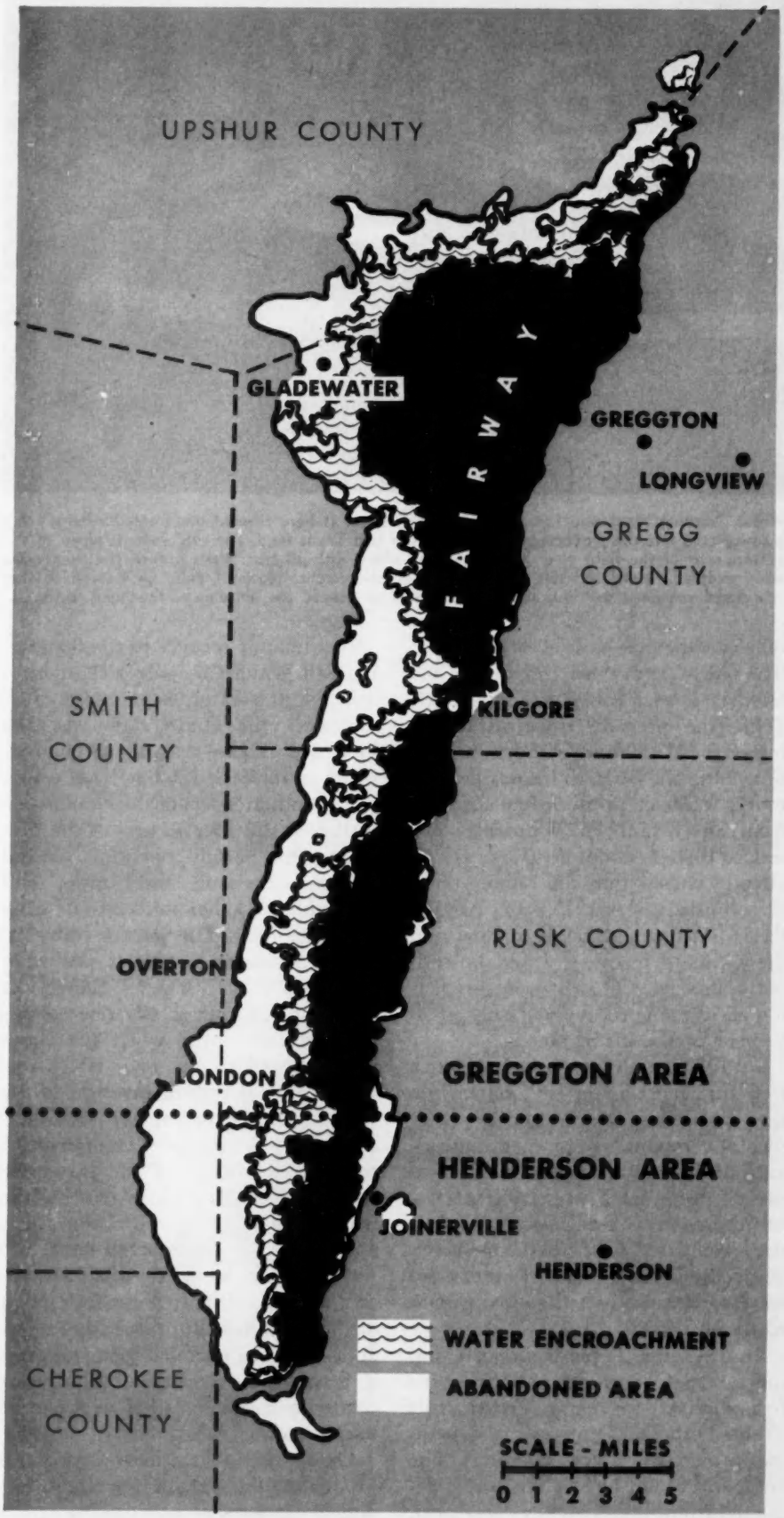
Along with the billions of dollars worth of oil it has yielded, the East Texas field has contributed immeasurably to the science and philosophy of oil production. The crises and confusion attending the early development of the field were only temporary. From them grew effective proration laws, sound production engineering practices, and the modern concept of maximum efficient production.

From the standpoint of production practices, the water injection and pressure maintenance program has been the greatest contribution of the East Texas field. It is generally credited with being the first attempt to maintain reservoir pressure by field-wide water injection.

The accompanying map shows the extent to which the field has suffered water encroachment from the west. While the north end—the "fairway"—has not been too greatly affected as yet, over half of the southern portion has been abandoned. In a few years the water will split the great field into three segments. The mechanics of water encroachment are indicated in the accompanying simplified cross section of the Woodbine reservoir. The diagram illustrates the basis for the field's salt water injection program.

Salt Water Problem. Salt water was produced with the earliest wells drilled on the west edge of the field. As development progressed, water production grew proportionately—2000 barrels a day in 1932; 15,000 in 1935; 100,000 in 1938; 200,000 by 1940; and 300,000 in 1941. By 1938 salt water disposal had become a major problem. The following year, a court injunction prohibited further pollution of the Angelina and Sabine rivers. Other disposal methods—evaporation pits, a pipe line to the Gulf—were impractical.

Return of the water to the Wood-



Still a Giant Despite Shrinkage—The great East Texas field is gradually narrowing from west to east as oil is taken from the producing formation and replaced by salt water. The field originally was about 43 miles long from north to south and 5 to 8 miles wide, from east to west. But it has produced over 3 billion barrels of oil in 25 years. And the white areas on the west side have been abandoned. Farther east in the crosshatched area there is now water encroachment. The salt water, coming in from the west, has not yet reached the black areas on the east side.

Water Treating Plant and Injection Well—Salt water is here filtered and treated, after which it is re-injected into the producing formation of the East Texas field. The salt water is piped to this western part of the field after being produced along with oil from wells toward the east. After being exposed to air, the salt water undergoes chemical changes. It must be treated so that deposits from it will not stop up the formation around the bottoms of the input wells.

bine was the only satisfactory solution. The idea received impetus from another serious problem facing operators—the pressure decline in the reservoir. With fluid withdrawals approaching the 800,000 barrels per day mark, reservoir pressure had dropped from an initial 1620 pounds per square inch to about 1040 psi. It was already known that the bubble point of solution gas was 755 psi. At that level, wells would cease to flow and the ultimate recovery would be seriously affected. Oil men were predicting an ultimate recovery of only 30-40 percent of the oil in place.

In 1938, one operator converted a well for injection of salt water into the Woodbine. By the end of 1941, several companies were operating private disposal systems, and water was being injected at a rate of 65,000 barrels a day. This was, however, only a drop compared to the 320,000 barrels being produced. These projects did serve to demonstrate the effectiveness of the method.

In 1942 the Texas Railroad Commission issued an order permitting the formation of the East Texas Salt Water Disposal Company, a cooperative project by 15 field operators. The company would collect salt water delivered from producing leases, treat it, and pipe it to injection wells. As an incentive to operators to deliver water for reinjection, a bonus of one barrel of oil over the well allowable was given for each 50 barrels of water injected. This bonus was calculated to approximately recover to the operator the Salt Water Company's charges for injecting the water. As the price of oil increased, the bonus ratio was also increased. Today it stands at one barrel of oil for each 126 barrels of water.

Two other orders of the commission furthered the effectiveness of the program. One permits operators to shut in large water wells and transfer their allowables to other wells on the lease or in the field. The second restricted the oil allowable in ratio to salt water produced to 10 (later 5) barrels of water to 1 barrel of oil. The restriction did not apply when the water was returned to the reservoir.

The major problem involved in the subsurface disposal of the salt-water aside from corrosion of equipment—concerns treatment of the water for return to the reservoir. Collecting the water, running it to injection wells, and flowing or pumping it back into the formation would be relatively uncomplicated, if that were the extent of the operation. But the water undergoes extensive chemical changes after it leaves the reservoir, and must be treated and stabilized before it can be re-injected.

Once the salt water has been brought to the surface it is almost impossible to prevent its exposure to the air. When exposure occurs, certain elements in the salt water are oxidized and form insoluble precipitates which collect on the face of the formation in the injection well, sealing off the sand and reducing or destroying its ability to take the salt water from the well. Scale formation is often accelerated by algae and bacteria in the water which reduce sulfates to insoluble sulfides, causing the "black water" problem with which the field is recurringly afflicted.

Salt Water Disposal Company maintains a number of treating plants throughout its system. Salt water taken from individual leases goes through gravity lines to a treating plant, or to a collection station where it is pumped to a plant. A typical treating plant consists of a receiving-skim barrel or a skim pit, an aerator, a treating pit, a chemical storage and mixing house, three pressure filters, a backwash pit, a surge tank, an overflow pit, metering equipment and connecting lines.

Here waste and entrained oil is removed, and the water is thoroughly aerated to encourage oxidation of soluble compounds. Following aeration, the water is chemically treated to further the oxidation process, and to kill algae and bacteria. Most of the "floc," or solid particles in the water, is removed in the treating pits. Finer floc particles remaining in suspension are removed in the pressure filters. When it leaves the filters, the salt water is chemically stable and free of nearly all foreign substances, and ready for injection.

Success Amazing. The program has been amazingly successful. From 23 percent in 1942, the ratio of salt water injected to the total water produced had climbed to 90 percent in 1947, and since 1952 has remained consistently above 98 percent. Salt Water Disposal Company handles about 82 percent of the total injected, private systems the remainder. At the beginning of the year, over 2 billion barrels of salt water had been returned to the Woodbine.

Reservoir pressure, which had declined to a low of 1000 pounds in 1944, is currently about 1030 psi. And reservoir experts now predict that up to 90 percent of the oil in place will ultimately be produced. They believe that the water injection program eventually will represent 600 million barrels of oil recovered over and above the total which could have been produced by primary methods.

ACKNOWLEDGMENT

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How to S-t-r-e-t-c-h Your Power Dollar

• Savings on electric power bills can be made by taking advantage of lowest rates to which users are entitled.

• The 'art' of purchasing power involves studying operations and securing billing at best available rates.

• Case histories reveal oil company savings of as much as 12 percent in power costs.

By LUTHER W. DAVIS
Power Cost Engineers, Inc.
Dallas

CONSUMERS, INCLUDING oil companies, could save millions of dollars per year on their power bills.

Like concerns in other lines, many oil companies are paying too much for their electricity. Without realizing it, they are purchasing power at higher rates than they could obtain under existing schedules.

The oil industry, by and large, does a topnotch job of turning out goods and services. Why, when the same management skills are involved, is the power service function so often neglected? The answer seems to lie in a lack of awareness of the profit potentials of the power services.

It would be impossible to discuss even a fraction of the many ways of reducing power costs here, so only some of the basic principles will be touched.

What happens when sound managerial principles and wise power-purchasing policies are put to work? Examples of the resulting benefits are legion and actual cases could be cited endlessly.

Here are typical cases, selected because they show, in various ways, the application of some of the principles to be discussed. The cases are real, *and so are the profits.*

• Oil company being billed on a special electric rate negotiated several years ago. By changing to one of three standard wholesale rates used generally elsewhere by the utility, the company had a reduction of 12 percent in power costs.

• Oil company's entire power requirements metered and billed on generally applicable rate schedule. Investigation revealed that 75 percent of the consumption was in equipment qualifying for a lower rate classification. Therefore, services were separated and metered and billed at two points for a recurring annual reduction of about 8 percent in power costs.

• Oil consumer billed on a general power contract rate and the net cost was less than 1 cent per KWH. It was discovered that one of the contract rider provisions was not being applied correctly. The proper application of all provisions of the rate, approved by the State Commission, resulted in a reduction of a monthly power bill from $845.11 to $776.09.

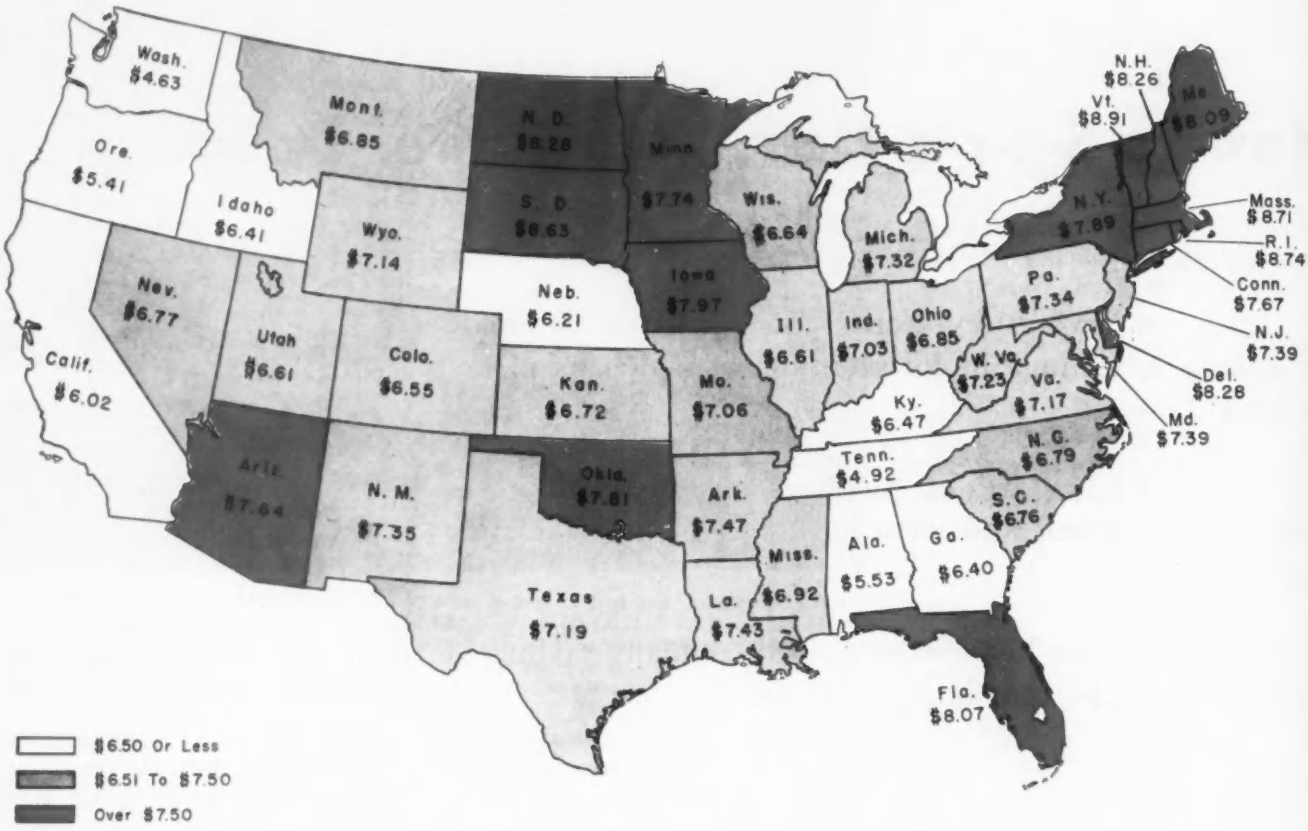
• Oil company owned transformer and was being billed on a rate structure created especially for oil field usage. By changing to a rate available to any commercial or industrial consumer, saves about $170 a year and the utility furnishes the transformer. Company salvaged two poles and a small transformer, without any wiring changes or investment.

• Local manager of utility declined to apply lower electric rate applied for, but was glad to apply it when he learned his company was using this same rate in another area served by them. The result—a saving of $5000 a year for the oil company.

Art of Purchasing. In two senses, the purchase of electricity for industrial use is an art. One side of the problem that has been long and widely considered by many engineers is expressed in the question, "Shall we buy or make?" Assuming the correct answer to be "buy," as is often the case, the second problem is "How shall we buy?"

About the Author

LUTHER W. DAVIS, a native of Texas, has spent his entire professional life working for the consumer interest in matters pertaining to utility costs. Even before receiving his license to practice law in 1937, he was utilizing his rate engineering experience in this work. Working from Dallas, he has been a power cost consultant for the consumer throughout the U. S., Hawaii and parts of Canada with "Rateonics" (rate engineering).



How rates vary from state to state . . .

FIGURE 1—Not generally known, rates vary considerably between two different consumers on the same utility, or exactly the same number of KWH used. This map shows the state average monthly bill for 250 KWH residential service. (As of January 1, 1954. Source: FPC Annual Report.)

To many executives, this second question will seem strange. With the idea that rate schedules are fixed in most localities, they see no "art" in buying, beyond signing the contract, making the connections, exercising reasonable care in the use of current —and, paying the bills.

And, in so over-simplifying the problem, they repeat the mistake that in the national aggregate costs industry millions of dollars annually. To avoid this error and salvage these losses, management must learn to recognize that the buying of electricity is an art demanding skill equal to the best applied in power generation.

In addressing this report primarily to top executives, who are not assumed to have special knowledge of power-service technology, we speak also to the engineers who are familiar with such utility rate "factors" as power factor, load factor, responsibility load factor, capacity and usage factor, utilization factor, demand factor, diversity factor, coincidence factor, operation factor, etc., all of which have a direct bearing on the lowest net power costs available.

Profit-opportunity in the power services is often neglected because management does not realize that the responsibility is theirs to qualify for and request the power company to bill them on the rate of their selection. One power company goes so far as to point out in their standard contract:

> "The consumer should analyze and study his operations from time to time for the purpose of determining the desirability of changing from one available rate to another. The company does not assume responsibility."

The reason for this is expressed this way by one utility company:

> "We cannot assume the responsibility of checking all bills at all times to assure the best possible rate application. To do so would greatly increase our billing costs and consequent cost of service."

It has been held that it would not be reasonable to require the utility companies to check up at frequent intervals to determine whether the character and extent of the customer's service had so changed as to entitle him to a more favorable schedule—or whether new rates had been created which would reduce the customer's costs.

The utility companies desire to give the best possible service. However, rules made (and in the rate schedules) to comply with the reasonable demands of one diligent consumer, may be, and often are, overlooked when the next consumer comes along. The utility employe fixing your rate does the best he can, and it is your duty to see that his attention is called to any rate that he has honestly overlooked . . . and to keep everlastingly on the job in the future, to detect any new way to reduce your costs.

Most of the utility companies have designed rate schedules which give their customers the benefit of lower

rates for special or larger uses of the service. Many state public service commissions do not permit special contract rates, but insist that even a special agreement with an individual customer, covering special conditions, must be filed as a rate schedule without mentioning the name of the customer, so that any other customer who meets the same conditions at a later date is automatically entitled to service under the same schedule, if requested in the proper manner. Many of the rate schedules are known as optional rates. The customer can take service on whatever basis under the established schedule he can figure will produce the lowest bill for his particular use or business, when he discovers and applies for it properly.

Experts' Job. Utility rate schedules and contracts are complicated. To describe the conditions under which a utility will render service, a specialized terminology has been employed. These specialized terms are not defined in a dictionary or glossary to which all utilities subscribe. In many cases, the rate schedules contain technical expressions without defining their significance in detail.

"... whether defined or not, these technical terms may be used with quite distinct and contradicting significances by different utilities," the Federal Power Commission says.

These variations are due generally to differences in points of view, in emphasis, and in interpretation rather than to basic differences.

The Supreme Court of the U. S. in a utility case, said:

"Use of that term in a context of generality wears an appearance of precision which proves illusory when exact application becomes necessary. Relevant authorities and considerations are numerous and equivocal, *and different plausible definitions result from a mere shift of emphasis.*"

All of which probably prompted one State Public Service Commission to say:

". . . We could write a book on these contracts and probably would not cover all of the points that will come up in the next one. All these matters should be handled by competent experts representing the parties to the contract."

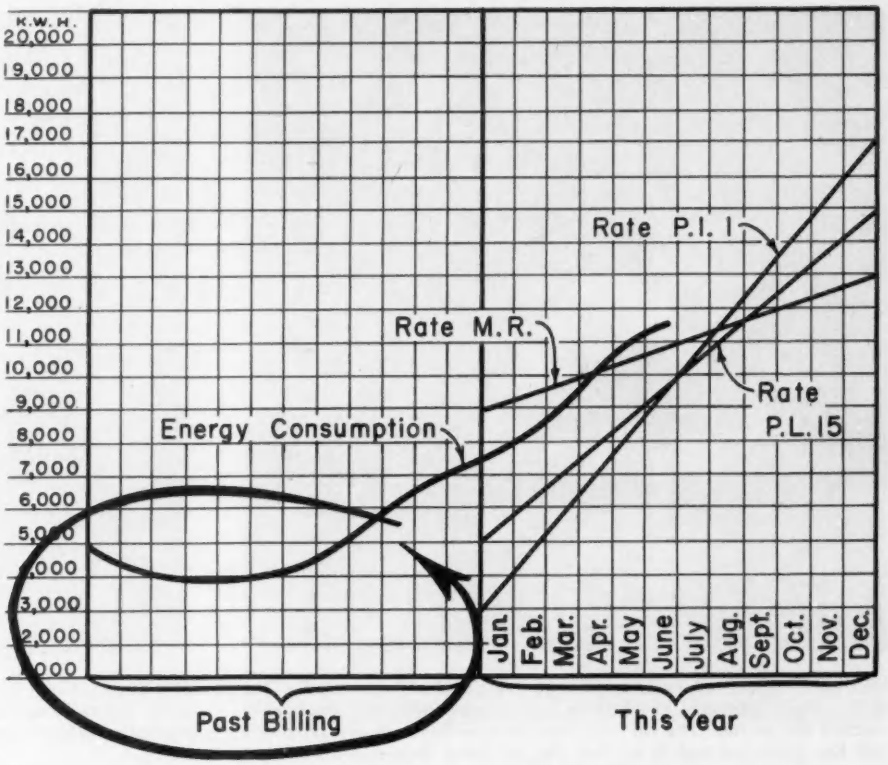


FIGURE 2—Electric power rates cross at some point when other rates may be used to an advantage. Have your monthly utility bills analyzed to protect you against irregularities.

Public Service Corporations, such as electric power companies, by reason of the extraordinary privileges accorded them, which include the right to eminent domain, the power to exterminate all competition, and the right to monopolize a business of vital import to the public, are quasi-public corporations engaged in a business affected with the public interest.

It is a universal rule that a public utility cannot discriminate in its rates or charges between consumers similarly situated. How does this work out in actual practice?

It is generally known that the price of electricity varies widely in different localities for exactly the same number of KWH used. But, it is not generally known that rates vary considerably between two different consumers on the *same utility*, for exactly the same number of KWH used.

For example, in one oil center four different customers' net power costs can be: less than 1 cent per KWH, 1.1 cents per KWH, 1.3 cents per KWH, 1.4 cents per KWH—*for exactly the same number of units of electricity used.*

This is not an isolated example of the difference in electric power costs for exactly the same KWH used. Rate Series No. 4 of the Federal Power Commission has examples from every area in the U. S., showing the difference in costs for the same amount of electricity from the same utility on different rate schedules available.

Analyzing Your Case. Are you paying more than you should for power? How can you find out?

The first thing, of course, is to find out exactly what you are spending at the present time. Then analyze all power rates over the entire system, including special rates, to see how the lowest purchase cost may be achieved and to see what it will be. Then continue the rate analysis and keep everlastingly at those elements of operation that neglected, boost the cost of purchased power.

In making a rate analysis, it is often not wise to depend entirely upon information that can be secured locally. After exhausing every available means to get lower costs, if you have any reason to believe you are paying excessive power costs, there are independent power cost specialists you can call on for needed advice.

—The End

FIGURE 1—Crude oil boilover without fire. In this demonstration the tank without water in the bottom was burned until the heat wave reached the bottom. The fire was then extinguished with dry chemicals and the water pumped in so that the oil being thrown out could be observed better.

FIGURE 2—Tank slopping over without fire. With an 11-inch heat wave, this tank was extinguished with dry chemical and then the foam applied to better observe the steam bubble expansion of the heat wave over the side of the tank.

Safety and Fire Protection—Part 1

How Oil Burns — and Why

What are the burning characteristics of crude? How does crude act when it burns? Answers to these and other questions vital to fire protection are included in this first article of a series by one of the nation's top authorities on safety and fire protection.

By J. L. RISINGER
Maplewood, N. J.

EFFECTIVE FIRE PREVENTION and fire fighting depend on two important factors:

- Knowledge of the conditions under which a substance will ignite.
- Knowing how the substance burns once it is ignited.

All substances have certain common characteristics—they burn only when converted to vapor or broken up into finely divided particles and mixed with oxygen in some form and correct volume proportion. In all but a few rare cases, oxygen comes from the air.

Oil and its products can burn only when the flames are fed by vapors from it, mingling with oxygen in the air in the correct volume percentage. This supports the belief that there is only one way to put out a fire. That is

Watch for other installments in this series in your WORLD OIL

by breaking up—throwing out of balance—the volume percentage ratio.

In the case of oil and its products, the percentage range of vapor in air is narrow, thus it can be unbalanced easily to prevent ignition; and if burning, may be more easily unbalanced to extinguish the fire.

Since no two crudes have the same characteristics, each type crude presents a different fire problem. To better understand the burning characteristics of an individual crude, it is essential to have a working knowledge of the following physical characteristics:

1. Initial Boiling Point. The temperature in an open container at which the lightest hydrocarbons will leave the mass of oil at sea level atmospheric pressure (boil-off) as a vapor.

2. Final Boiling Point. The temperature at which the heaviest hydrocarbons of the crude will vaporize. As most crude oils have a final boiling point higher than their ignition temperature, tests of the final boiling points have to be obtained in vacuum.

3. Boiling Range. That range of temperature from lowest to highest during which all fractions of differing gravities and boiling points will be converted to vapor or gas.

4. Ignition Temperature. The lowest temperature of heat required to ignite the vapors from a specific oil.

5. Fire Point. The lowest temperature at which an oil will give off vapors sufficient to burn continuously at its surface for at least five seconds.

6. Flash Point. The lowest temperature at which an oil will give off vapors sufficient to form a flammable mixture with air that will flash across the surface when ignition temperature is applied.

7. Explosive Range. All concentrations of a mixture of flammable vapor or gas in air (usually expressed in percent by volume of vapor to air) in which a flash will occur or a flame will travel if the mixture is ignited.

8. Ends, Light. That group of hydrocarbons composing the first few of the lowest boiling points of the boiling range of an oil.

9. Ends, Heavy. That group of hydrocarbons composing the last few of the highest boiling points of the boiling range of an oil.

10. Specific Gravity. The ratio of the weight of equal volumes of a substance and water. As applied to oil products, it is customary in this country to take the weights of both the oil and of the water at the temperature of 60° F. The specific gravity, therefore, is usually designated as "Specific Gravity at 60/60° F."

11. Vapor Pressure. The tendency of a substance to vaporize. Vapor pressure of a liquid at its boiling point is equal to the ambient atmospheric pressure, on the absolute scale.

HEAT WAVE CHARACTERISTICS OF CRUDE OIL

Crude oil fires, like refined oil fires, are extinguished by unbalancing the required proportion of air and vapor that is forming the burning mixture. However, the reaction of some crude oils to heat input from surface burning in tanks and pools known as their heat wave establishing characteristics may require a different technique in application when water or foam is to be used.

FIGURE 3—Author J. L. Risinger uses air agitation to bring oil, not heated to its flash point, to the surface. This is one of three methods which can be used to put out a fire by breaking up the correct vapor-air mixture. Other methods include reducing the air content below that required, as with CO_2 or dry chemical, and reducing the vapor content below that required, as with foam, which blankets the surface.

Let's suppose that a crude oil cone roof tank has been ignited and all or part of the roof is off so that the vapors above the surface can mix freely with air in burnable ratio and are burning freely. What is happening? The heat is now above the liquid. The surface of the oil is being heated. The high gravity low boiling point hydrocarbons are leaving the surface and mixing with air. They are forming the fuel that feeds the fire.

What Is a Heat Wave? In the case of some very narrow boiling range crude oils (like all refined products) heat penetrates only a shallow surface layer from continued burning. In the case of the usual wide boiling range crude oils, the lower boiling point higher gravity hydrocarbons come out of the surface and feed the fire, while the high boiling point hydrocarbons sink toward the bottom or at least through the heated surface, forming a heated front to heat the cold oil deeper and deeper as the fire continues to burn. This is called a heat wave.

It is assumed that in the progressive heat wave of a burning crude oil tank, the light ends come off in quantity as long as any are present. This maintains the temperature of the heat waves at close to 300° F. until the light ends are gone.

Actually the rise in temperature is progressive but in steps; as the light ends boil out and are consumed, there is less and less vapor space between the base of the flame and the surface of the oil, thus causing the surface temperature to rise rapidly when no more light ends are available for distillation.

As the temperature rises at the surface, distillation of

About the Author

J. L. RISINGER is making public for the first time the vast store of experience he has accumulated through 33 years of working in the field of safety and fire prevention. Now on assignment as advisor on fire protection to the Iranian Oil Refining Company, Abadan, Iran, Risinger recently retired from Socony Mobil Oil Company after 37 years of service. He is now a special consultant on safety and fire protection. Risinger's extensive research equips him to provide, especially to those handling and storing petroleum and its products, information that will be of great benefit to them. He has organized as many or more safety and fire protection programs as any other man—and these programs have been as successful and obtained as much result as any others that have been organized. Risinger is the inventor of the air agitation method of extinguishing and controlling to more easily extinguish oil tank fires. Some of his new methods of controlling fires have never been published. They will be described as they fall into application in this series of articles. The author will answer any questions you may have regarding articles which appear in this series. Please direct your queries to J. L. Risinger, 13 Euclid Avenue, Maplewood, N. J.

heavier ends commences and the temperature of the heat wave in some crude oils may rise to as high as 600° F.

In the case of the burning tank, these heavy ends sink through the mixture of lighter hydrocarbons, and impurities, until they reach specific gravity equilibrium in the oil balance. Since they are hot, they give off some of their heat on their descent, thus distilling off some more light ends.

Thus the heat wave grows, based on heat input and vapor output, until all but the heavy ends are gone, or the heat wave reaches a water or emulsion layer and causes a steam explosion.

In some crude oils this deepening layer or heat wave travels downward into the oil only three inches per hour faster than the burn off, while in others it may travel as much as fifty inches per hour. In most crude oils, the rate is from twelve to eighteen inches per hour faster than the burn off.

Just what part the impurities in crude oils contribute to the heat wave establishment and to the rate of its travel is not known.

Rainy Day Heat Waves—It has been noted in tests that anything which takes heat from the heat wave retards its travel downward. During long tests on a day of showers and sunshine, during the showers, the heat wave travel practically stopped and would start again when the shower ceased. This brings up the question of the effect of a water content on the heat wave travel in crude oil.

Why does such a heat wave not form on refined oils? There may be several reasons, the chief of which is the narrower boiling range of the refined oil below. This refined oil below the surface is composed of a range of gravities sufficiently narrow and with few impurities so that there is not sufficient difference in the weight of the larger heated particle at the top to carry it down into the mass of oil and at a rate to deepen this heat layer faster than the burn off.

Tests reveal that this will not occur even in a mixture of refined products from which the impurities have been removed. Tests in which a mixture of cracked gasoline, kerosine, Number 2 fuel oil, and Number 6 fuel oil have been used and on which no heat wave was established, further indicate that perhaps the impurities, water content, other foreign matter, and perhaps free carbon, in crude oil has a greater influence on heat wave establishment and the rate of travel of such a heat wave than heretofore accredited.

BOILOVER AND SLOPOVER OF CRUDE OIL

The story of the heat wave establishing characteristics of some crude oils is incomplete unless mention is made of the characteristics of the oils to boilover or slopover because of the heat wave, viscous character of the oil, the invariable presence of water in the tank and the water content of fire foam, the chief agent used to extinguish large low flash point cone roof tank fires.

It is common usage in fire protection regulations to classify tanks as those containing refined petroleum products or other flammable liquids not subject to boilover, and tanks containing crude petroleum. The National Fire Protection Association model ordinance formerly referred to the latter in terms of crude oil and other oils subject to boilover. After long experience of the oil industry and many tests, the phrase, "crude oil and other oils subject to boilover," has been deleted and the words "crude petroleum" used instead.

What is Boilover?—To illustrate the term "boilover," it is only necessary to assume that the crude oil tank burning at the surface and establishing a progressively deepening heat wave or layer into the body of oil is permitted to continue burning until the heat wave reacts on water under the oil. Since the temperature of the oil in this heat wave ranges from 300° to 600° F. dependent upon the kind of crude oil and time of burning, it is inevitable that some of this water will be converted to steam, expanding approximately 1700 times and in accordance with the amount of water so converted and the depth of oil above it, piston a quantity of the burning oil out of the tank.

To have a boilover three things must be present. A heat wave that penetrates to water below the oil, the water to be converted to steam, and a viscous oil through which steam cannot readily pass from below.

What Is Slopover?—In the case of a slopover, the oil acts differently from that of a boilover. Although still dependent upon the heat wave and its depth, a slopover is usually man-made in his effort to extinguish the fire, sometime between the time of the establishment of a

FIGURE 4—To determine if an oil has heat wave, boilover and slopover characteristics, allow a drum (such as the one shown above) to burn for at least one hour and observe the depth of change in color of heat detecting paint. Here the change was deeper because of the heat input from the shell of the small container above the liquid.

FIGURE 5—Crude oil is shown slopping over when foam is applied; likewise it would boil over if permitted to burn until the heat wave reached water under the oil.

sufficient heat wave at the surface of the oil and the time at which the heat wave reaches the water at the bottom of the tank.

While a boilover is both a frothing over and a throwing of the oil by the expansion of water to steam under the oil, a slopover is a frothing over of the heavy ends of the oil by the formation of steam bubbles in them when water sinks into the heat wave.

If water or fire foam, with a water base, is applied to a heat wave, it sinks into the heat wave, and is expanded into steam. On its way out, the steam forms a froth or steam bubbles which expands the hot oil in the heat wave to a greater capacity than the outage of the container, in accordance with the depth of the heat wave and the outage of the container, and thus causes the froth to spill over the top of the container.

Reactions from Water or Foam—The question is often asked, "How deep must the heat wave be in order to have a slopover when water or foam is applied?" This varies, depending upon the outage of the container, the viscosity of the oil, and the rate of application of water or foam. For instance, some slopping can be caused on oils such as Number 6 fuel oil which does not have heat wave establishing characteristics. This can be done by filling a container to a level with the top with viscous refined oil and igniting it.

Within 15 minutes, the heat layer at the surface will be about one and one-half inches in the small container, chiefly from heat of steel nearby, but which will not increase regardless of how long it burns. At the end of 15 minutes the drum will remain practically full so that the expansion even of the thin heated layer will spill some of it over the side. This is not a true slopover, but an illustration of one, for to have a real slopover, the oil must have heat wave establishing characteristics.

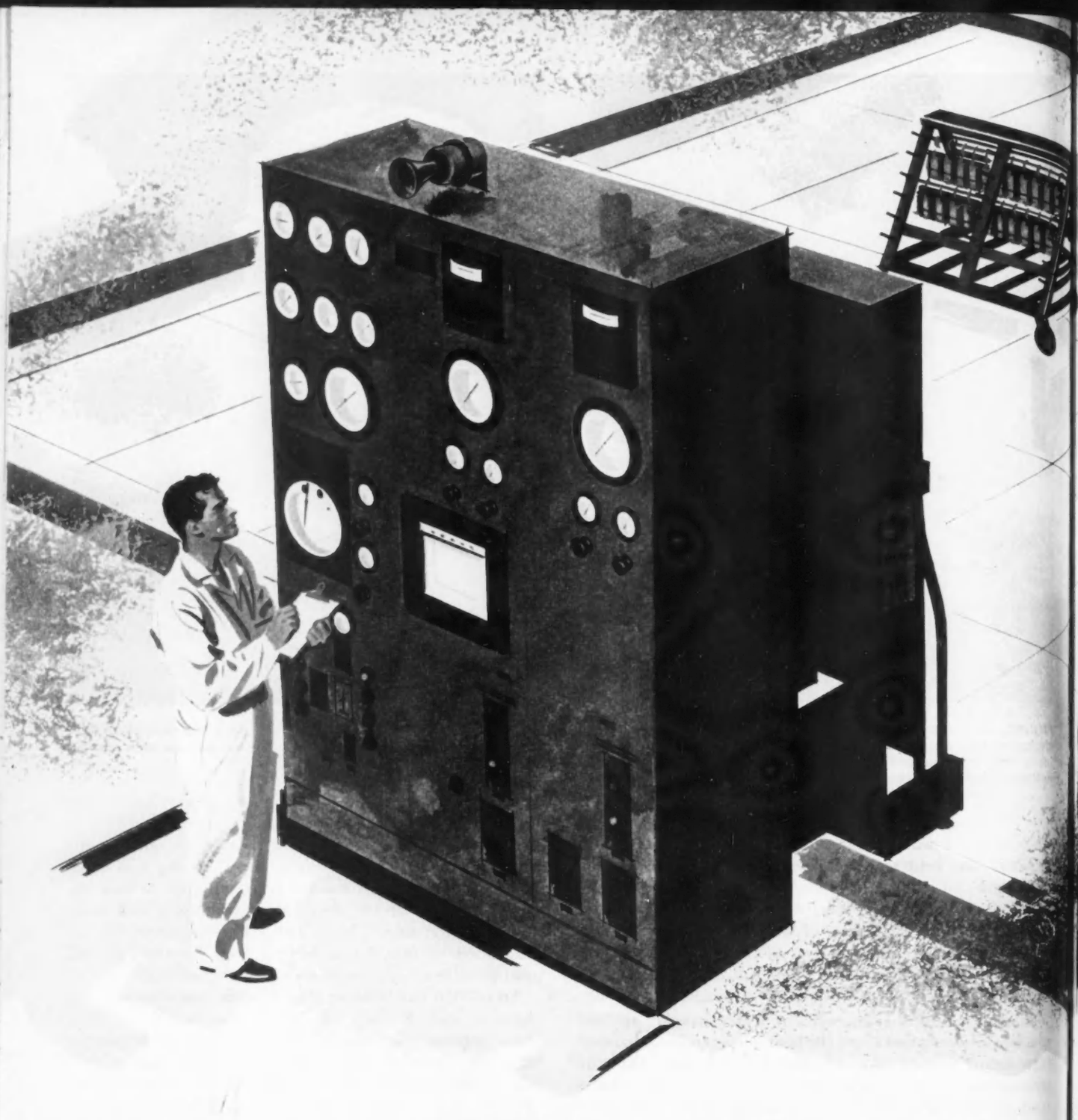
An oil that has boilover characteristics also has slopover characteristics. Refined oils do not have boilover or slopover characteristics because they do not establish deepening heat waves. Some of them are more viscous than some crude oils that do have boilover characteristics, but the thin heated layer at the surface is not deep enough to cause either.

HOW TO DETERMINE HEAT WAVE CHARACTERISTICS

There is a simple way to find out if an oil has heat wave establishing, boilover and slopover characteristics. Take a drum with head out, paint a stripe of heat detecting paint from top to bottom, fill it to within 12 inches of capacity and ignite it. Allow the oil to burn for one hour; then put foam on it. If you do not have foam, use water. Repeat these tests until you are sure of the burning characteristics of the oil (Figures 4 and 5).

Also, even considering that the heat wave traveled faster in the small container due to the heat input from the shell, an estimate of the burn-off and heat wave travel can be obtained.

Part 2 Will Appear in the March WORLD OIL



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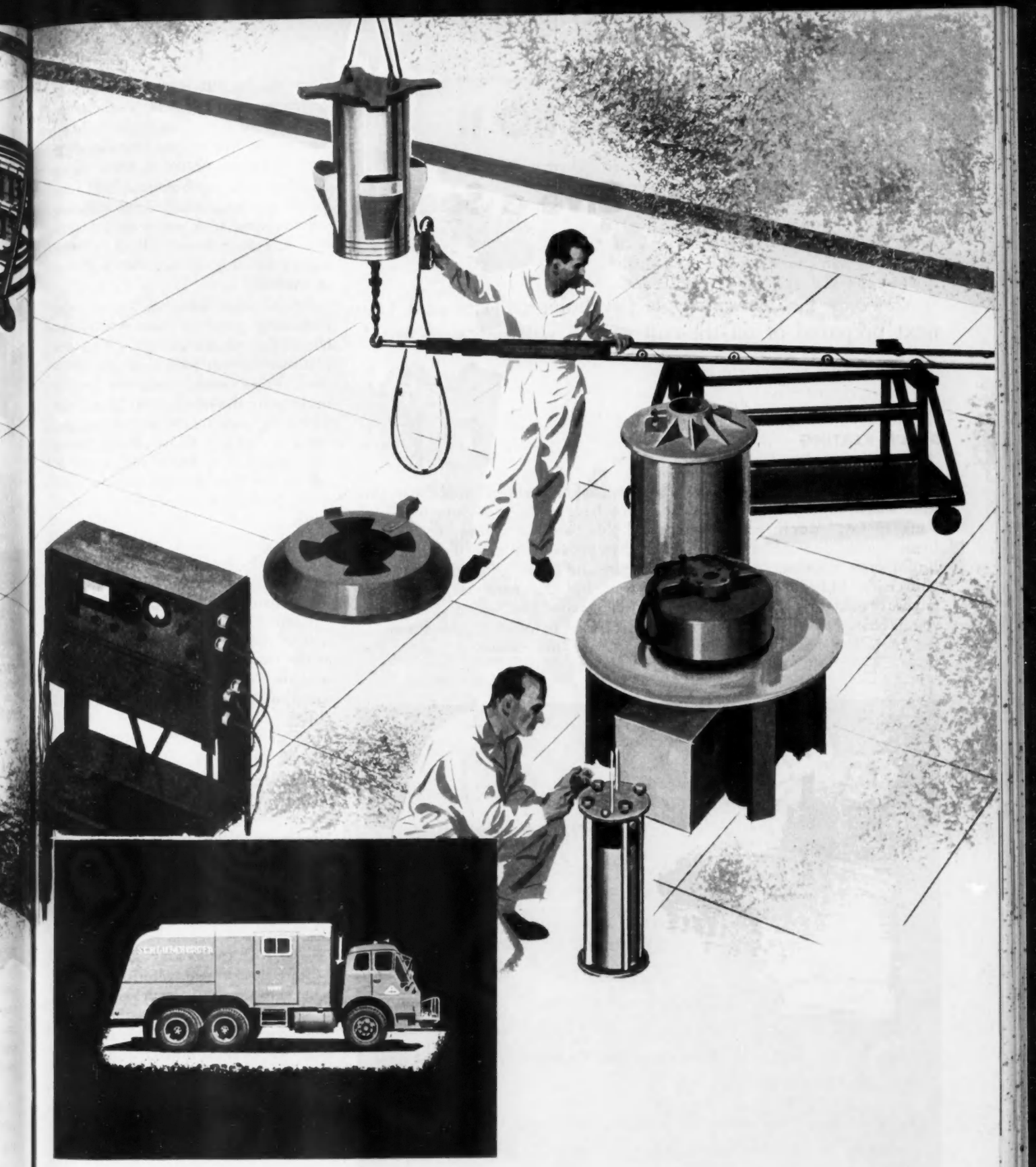


Schlumberger...to be sure!

How to Give a Speech

Use these simple psychological tips and your next prepared or off-the-cuff speech will be "sure fire."

By L. A. KEATING

"ANYONE CAN give a good speech who wants to and who has something to say," declares Professor Lynn Surles, director of Business & Professional Speaking at Marquette University, Milwaukee. Therefore, unaccustomed to public speaking as you probably are, if you will make use of a few basic techniques you can acquit yourself well next time you have to "talk on your feet."

You will, of course, be nervous. Even speakers of long experience perspire and fidget before they get under way. But the more you prepare, the less nervous you will be. Too, there are ways to combat nervousness.

"First, understand it," urges Professor Surles. "It is nature's way of keying you up to meet a challenge. You can get the upper hand on nervousness in two ways: by relaxation and by taking plenty of time.

"There is a psychological help, too. While the chairman is introducing you and you wish you were home in bed, say to yourself, 'Well, they're asking for this, so let the audience be nervous.' "

When your name is called, rise from your place as relaxed as possible. Take plenty of time. On the platform as you look over the audience, think about relaxing—your neck, your shoulders, your arms. See to it that your hands on the podium are limp. *Stand there taking plenty of time.* Your audience will wait. As you realize how patient they are, you gain confidence. Confidence erases tension.

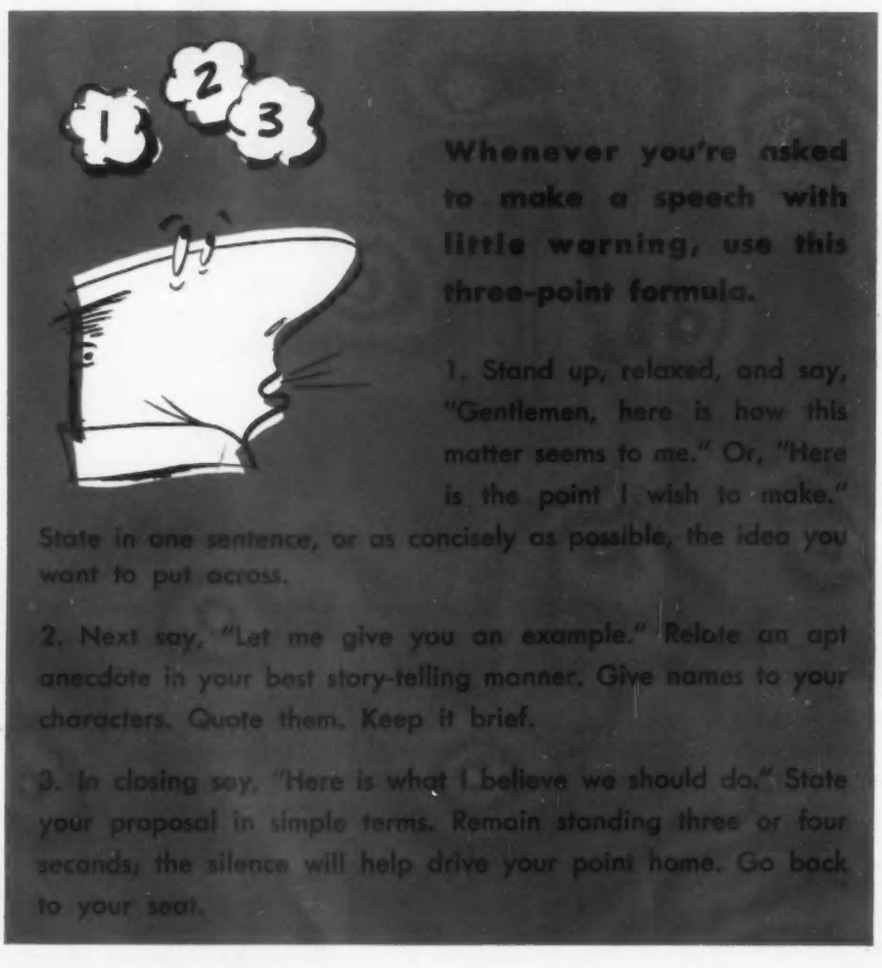
Sure you are ready now to begin? State your opening line and pause. Say another line. Pause. Look around. These pauses will calm you and they effectively grip your hearers' attention. Actually, the pause is as effective as the words you speak. As you make successive statements you will pick up speed and confidence, and as you notice the attentiveness given you, nervousness is forgotten.

Here is a trick about looking at your audience. It is dangerous to pick out individuals and watch their faces to see how you're doing. Shun this! Do not see anyone individually. While you talk, slowly sweep your gaze along the last two rows of the audience from one side of the hall to the other. Then slowly sweep back. Keep doing this, and every person facing you will believe you are looking at him.

Start in low gear, offering earnestness and sincerity. Your enthusiasm will rise and carry you to the needed heights in good time. Remember, you make the greatest impact with earnest understatement followed by a pause. Never yield to excited exaggeration.

Gestures? Don't force them or experiment or imitate. Just do what comes naturally.

Now let's go back to preparation of your speech—because an audience worth talking to is worth doing your best for. Never read your speech: that puts people to sleep. Of course you may have to read brief technical passages or quotations; but reading takes your attention away from your listeners. Never memorize your speech, be-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Whenever you're asked to make a speech with little warning, use this three-point formula.
1. Stand up, relaxed, and say, "Gentlemen, here is how this matter seems to me." Or, "Here is the point I wish to make." State in one sentence, or as concisely as possible, the idea you want to put across.
2. Next say, "Let me give you an example." Relate an apt anecdote in your best story-telling manner. Give names to your characters. Quote them. Keep it brief.
3. In closing say, "Here is what I believe we should do." State your proposal in simple terms. Remain standing three or four seconds; the silence will help drive your point home. Go back to your seat.

cause if you forget a couple of lines you may be headed for disaster.

The best approach is to know *what* you want to say. When the time comes, you'll find the words for saying it. Jot down on a card or a sheet of paper the list of topics you want to cover. Be sure their sequence is logical and effective. Place your card on the podium where you can see it but your audience cannot. Discuss your first subject and stop. Take up your next item. When you have discussed your final point, wait 4 or 5 seconds, then leave the podium.

What if someone heckles you? It's risky to attempt to match wits with a heckler; you may lose and look foolish. Instead, take a step or two his way and gaze at him in silence. Then turn back and resume your talk.

"Use all the anecdotes you can to illustrate the points you wish to make," Professor Surles advises. "Anecdotes reveal people in situations, and audiences love them. Ninety percent example material and 10 percent of your own opinions will hold reader interest. Later, people will forget your assertions but remember your anecdotes. Get used to saying, 'When this point came up at another meeting—' or, 'Let me illustrate with an experience I had.' "

To sum up: prepare your speech by making a list of subjects you can jot down on a small card. If possible, give the speech aloud once or twice to an empty room. When the chairman introduces you, fight nervousness with deliberateness. Speak slowly, with frequent pauses. Look at the mass of faces, never at individuals. When you finish what you planned, do not repeat or re-emphasize or continue. Wait a few seconds, then return to your seat.

What if you are called on unexpectedly and you are puzzled what to tell a group? In the few moments you have to think, ask yourself: How can I help them? The answer is what you should talk about.

So, next time you hear a chairman say those fateful words, "It now gives me great pleasure to introduce—" and mention your name, why worry about being nervous? It's as inevitable as taxes. But you can control it by trying to relax and by taking plenty of time.

Remember, these folks must want you to talk. They're asking you to, aren't they? **—The End**

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

- The most important contribution of oil comes in the form of energy which multiplies our capacity to work. The heat engine, working in industry and agriculture, enables us to produce more goods and raise more food.

  In 1900 each farmer provided enough food to supply seven other people. He lived a life of toil that few Americans today would understand or willingly tolerate. Now one farmer grows enough food for almost 20 other people—and takes far less out of his own hide doing it, thanks to oil.

•

- It is estimated that one-half of everything we enjoy above the subsistence level of living is attributable to savings in time and cost resulting from the use of cars, trucks and tractors in commerce and industry. How many of these modern modes of transportation would be on the road today without oil products?

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- Oil and gas provided the basis for 25 percent of the nation's total chemical production in 1955—and for 80 percent of all the organic chemical output.

•

- Per capita consumption of oil in the U. S. is 20 times as much as in the rest of the world, and 67 percent of the total energy requirements of the U. S. are now supplied from oil and its products. In part this is due to the plentiful supplies developed by an aggressive industry. In part, also, it is due to making this highly versatile form of energy available at low cost.

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- In 1955, the U. S. accounted for 57 percent of the world's refining capacity. Western Europe accounted for 15 percent. Today, however, about 60 percent of the refining and petrochemical plants being constructed or planned are outside the U. S.

•

- Some 8 million homes in the U. S. are now heated by oil, and we are raising a whole generation of young people who would never think of associating a snug house with an ax or shovel.

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Remember: Oil can't speak—you can. Only you can give the non-oil public the true facts about your oil industry.

Tankers Best for Transporting Mideast Oil

• Tank ships are the most reliable answer to the problem of insuring a steady movement of oils from the Middle East to the consumers.

• Pipe lines and canals are undependable since the oil movements through them can be halted by political and military action.

• Governments should give priority to tanker construction programs during the next several years.

By THEODORE WILD
Washington, D. C.

TANKERS ARE the basic answer to the problem of providing dependable transportation for Middle East oil. They will keep the oil moving steadily to consumers. Pipe lines and canals will not surely do so. Oil movement through them can be too easily stopped through political or military action.

Choosing a system of transportation for Middle East oil should receive the most mature consideration before any final step is taken. Any decision should be devoid of sentiments. It should be realistic. Facts and figures together with geography and long range future international prospects should be the deciding factors.

Let us examine the problem in its several aspects. Recent happenings have shown that dependence in any form in transporting Middle East oil is not desirable, whether it is dependence on a canal or on a right of the way. Therefore, it should be the desire of all interested parties to divorce themselves from plans or commitments which entail dependence. This fundamental desire of complete freedom of action certainly favors the tanker system of transportation.

All oil-producing countries of the Middle East are entirely dependent on their oil revenues. Their whole economic structure, fiscal policy, and prosperity are based on the systematic production of their oil. This fact was noticed in the case of Iran. It may be noticed again in Iraq unless the present stoppage of the flow of oil is soon remedied. It would certainly be the height of folly on the part of any of these oil producing countries to put itself at the mercy of its neighbors. The neighbor's policy, at best, is highly whimsical. Its continued friendly attitude can never be guaranteed. This aspect of our analyses again supports the tanker system of transportation.

The petroleum industry is now studying the possibility of constructing Big Inch crude lines from Iraq and the Persian Gulf north and westward through Turkey to the Mediterranean shores. The industry is assuming that it is improving its position by switching its dependence from the small Arab countries of Lebanon, Jordan and Syria to a bigger and stronger non-Arab country like Turkey, which also happens to be the eastern pillar of NATO. Let us examine and see if this switching is a realistic improvement.

The Mediterranean terminal of the contemplated pipe lines is the port of Iskenderun in southern Turkey, which in itself has been a bone of contention between Turkey and Syria ever since 1939. The province of Hatay, which includes the ancient cities of Antioch and the port of Iskenderun, was part of Syria when the country was taken over by France in 1916. In 1939, before the outbreak of World War II, Turkey negotiated with France and managed to take over the entire area. This caused considerable public displeasure in Syria. This displeasure has been on the increase ever since the Syrian independence in 1941.

Can any one foretell what will eventually come out of this Syrian-Turkish contention? If in the course of, say, the next ten years the Arab League solidifies its unity and closes its ranks, they could easily force a show-down on this issue, particularly if Russia supports their claims. Then Turkey would be sandwiched between two unfriendly forces. NATO might not be willing to risk a third World War in order to enable Turkey to keep the entire Iskenderun-Antioch area. One possible outcome of such a show-down may be a compromise by which Iskenderun may be returned to Syria (because Syria has no good port on the Mediterranean while Turkey has several). Then the petroleum industry would again find itself in the same mess from which it is now trying to escape.

The regime in Turkey has been friendly to the West. Who can predict the continued friendship of Turkey? Who can foretell the course of events? Were not Turkey and Greece friendly with one another and members of NATO? What happened to that friendship when the question of Cyprus came into being? Yet neither Turkey nor Greece intentionally planned the breakup of that friendship. Let us not forget that the Cyprus question still remains unsolved. Let us also remember that no one could have foretold the Cyprus episode, just as no one can guarantee now that similar episodes will never occur in the future.

Therefore, by depending one's conclusions on long range observations

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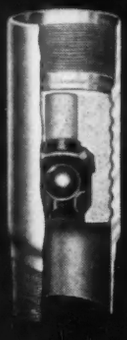

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and possibilities, rather than on the present and immediate scheme of things, caution and logic favors the tanker system of transportation.

Even irrespective of the above analyses, pipe lines through Turkey are more vulnerable simply because they are much closer to the enemy bases. In the event of any serious hostility with Russia, the first targets of the enemy bombers will be the pipe lines. Those nearest Russia will obviously receive the brunt of the enemy attacks. On the other hand, tankers are further from their reach. Even if the enemy planes succeeded in reaching the oil fields and the Persian Gulf area, the damages which they could inflict would not be half as paralyzing as if they attacked pipe lines. A whole oil field or an entire fleet of tankers will never be paralyzed or put out of service in one or two attacks. But pipe lines can be paralyzed in no time at all unless they are buried.

It is certainly a wise move to remove the basic industries from the proximity of enemy bases. Russia has been moving hers to and beyond the Ural mountains. In the modern scheme of things, perhaps next to steel, oil is the most basic industry. And a significant unit of the West's petroleum industry is situated in the Middle East. Nothing can be done about the location of the oil fields. But such attendant facilities as pipe lines and refineries can be kept as much out of enemy reach as possible.

Thus even from a tactical point of view the tanker system of transportation is more desirable.

It has been advocated to build a canal or a pipe line through Israel from the Gulf of Aqaba on the Red Sea to the Mediterranean shores. The objections to such schemes are manifold. For example, the Arab oil producing countries, in the present international tension, are not likely to allow their oil to pass through Israel, whether by way of a canal or by way of a pipe line. Even when Israel has a final peace treaty with her Arab neighbors, the Arab oil-producing countries will continue to patronize the countries of the Arab-League in preference to any other country.

Furthermore, the state of Israel will be at least as much influenced by problems of self-interest and territorial sovereignty as Egypt has been with her canal or as Syria and Lebanon have been with their right of way. We have no realistic reason to believe that Israel, or Turkey for that matter, will in the long run behave any differently when their interests and territorial integrity are involved.

Again our analysis and conclusions indicate that the system of tanker transportation of oil from the Middle East is seemingly the only system which insures complete independence of action to all concerned.

Another and perhaps the final aspect of this problem to be considered here is the possibility of finding oil in North Africa. Already oil has been tapped in southern Algeria. If substantial production should be developed, the natural market for North African oil is Europe, particularly southern Europe. Could Middle East oil then compete with North African oil in the Mediterranean markets? To all indications the answer is that it could not. Consequently, the presently contemplated Middle Eastern pipe lines would then serve to little or no purpose. Thus our analysis again favors the tanker system of transportation.

Some Suggested Action. Now that we have shown the superiority of tanker system of oil transportation, let us examine logical courses of action. Actions should be divided into two separate categories, one for immediate needs and one for long range policy. These are as follows:

Immediate Actions

- Repair the damaged Iraq pipe lines. This should be attended to immediately. The immediate flow of oil from Iraq is imperative. Otherwise, the present government of Iraq may collapse, and radicals may take over.
- Multiply efforts to reactivate the Suez Canal as soon as possible and to normalize it for its part in the Middle Eastern commerce.
- Meanwhile, keep European industries humming by multiplying efforts to supply their fuel requirements.

Long Range Actions

- To make transportation of Middle Eastern oil around the Cape of Good Hope a reality, orders for construction of supertankers should reach the shipyards of the world. All governments should give priority to tanker construction for the next few years.
- Pipe lines should be constructed to bring Kirkuk and other Iraqi oils southward to the Persian Gulf for eventual transportation by tankers.
- Facilities should be made ready to ship Arabian oil by tankers in case of emergency.
- The Suez Canal should be improved and used by the smaller tankers. However, the oil industry should gradually work itself free of the canal.
- If any pipe line is to be constructed, let it be constructed to facilitate the rapid and economical distribution of oil when it reaches its destination.
- It would be prudent to have existing and future Middle Eastern pipe lines buried.

—**The End**

About the Author

THEODORE WILD has gained most of his working experience in the Middle East. From 1933 to 1942 he was a geologist with A.I.O.C. in the Persian Gulf oil fields. For one year after that he was technical adviser to the Iran Government. The following year he served as director-general of the Department of Mines in Teheran. From 1944 to 1945 Wild made available to the Allies their mineral requirements in the Middle East as chairman subcommittee of the Middle-East Supply Committee of Allied Occupation Forces in Iran. Since 1950 his capacity has been as the U. S. Government supervising general engineer and geologist.

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By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Future Depends on Industry Action

U. S. market conditions in coming months can be either good or bad, depending on how wisely industry adjusts its operations so they fit requirements.

The outlook for U. S. oil is far brighter than could be anticipated a few months ago. However, much of this brightness is on the surface. Beneath the bright appearing surface are several disturbing factors that could easily become quite troublesome.

Now is the time for the industry to wisely manage its economic affairs. If caution is thrown to the wind, excess production, surplus stocks, and shaky price structures will return. The current situation provides the industry a wonderful opportunity to put its economic affairs in good condition. What happens will depend on what the industry does, whether it conducts its operations according to good sense and wise planning.

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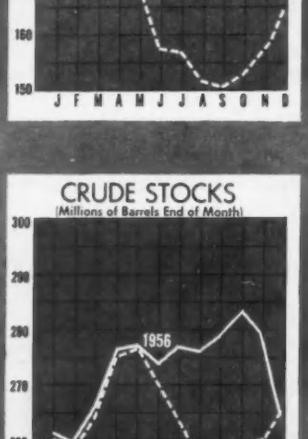
On the good side of the picture are such factors as increased demand due to the Middle East situation, the resulting increase in U. S. production, reduction of surplus crude oil stocks, and the posting of higher crude oil prices.

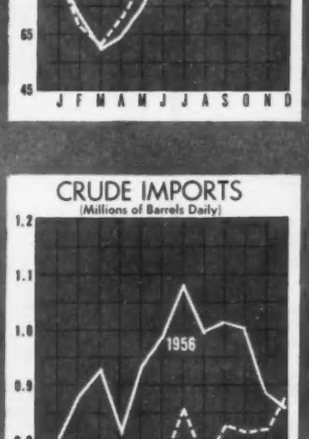
Increased exports to Western Europe to supplant disrupted shipments from the Middle East, coupled with a normal increase in U. S. demand, mean a larger than normal growth in demand for U. S. oil. Demand is expected to be strong through the first half of 1957, although Western Europe's demand could pass its peak with the end of winter.

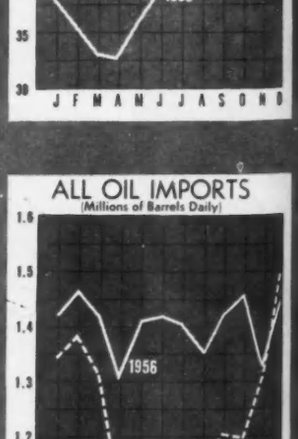
Increased demand already has resulted in substantially higher U. S. crude production, and in a long overdue and greatly needed advance in crude oil prices.

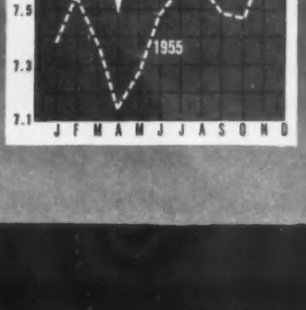
Excessive U. S. crude stocks have been reduced to satisfactory levels. U. S. crude stocks have dropped from 283 million barrels at the end of October, 1956, to only 260 million barrels on January 5, 1957, a reduction of 23 million barrels. Crude inventories no longer are excessive, the in-

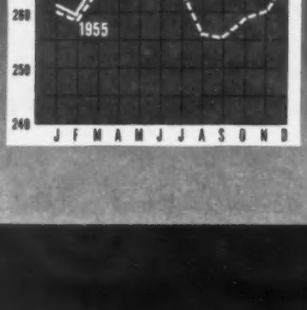
Petroleum Trends . . .

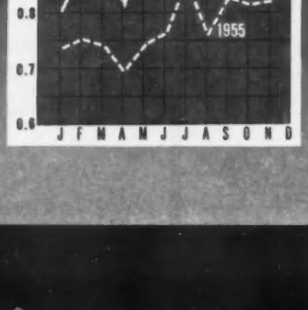


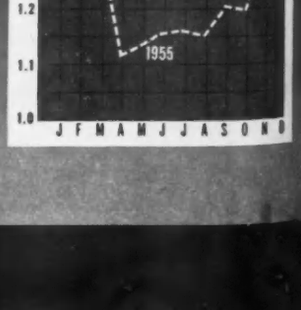












dustry needs to carry 260 to 265 million barrels for adequate refining and pipe line stocks.

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On the unfavorable side of the picture are such factors as excessive U. S. gasoline inventories, recent sharp growth in U. S. crude runs to refinery stills, and the temporary nature of Suez Canal effects.

Surplus gasoline stocks are a real problem at the moment, and likely to become more acute unless quick action is taken. U. S. gasoline stocks have increased by 16¾ million barrels since the end of last October, 4½ million more barrels than added during the corresponding period of the previous year. Inventories of motor fuel on January 11 totaled 189¼ million barrels, 23¾ million barrels above a year ago. At the end of October they were only 19½ million barrels larger than the previous year.

This is too much gasoline. Nevertheless, the industry has pushed gasoline production in recent weeks to an all-time high of approximately 4 million barrels daily. If this trend is permitted to continue, price weakness that will hurt both the refined product market and crude oil prices are sure to result. Increased demand from Europe will not help. Europe wants crude oil and heating oils, not gasoline.

The situation is being aggravated by high crude oil runs as well as high yields of gasoline. Crude runs to U. S. refineries have climbed to new peaks of 8¼ million barrels daily in recent weeks, 600,000 barrels above daily throughput last October and 250,000 barrels above last November.

The explanation that refiners must run record volumes to make enough distillate fuel oil to meet needs does not fit the statistical picture. U. S. distillate fuel oil stocks on January 11 were nearly 22 million barrels larger than a year before, although they had been only 6 million barrels above the previous year at the end of last October.

Refinery runs and yields must be adjusted to fit market needs and current supply conditions. If crude runs to stills were held to 8 million barrels daily and gasoline yields reduced about 1 percent (to 47 percent), gasoline production in recent weeks could have been held to an average of 3¾ million barrels daily instead of 4 million barrels.

U. S. Crude Production

(Thousands of Barrels)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION Dec., 1956	Nov., 1956	Dec., 1955	% Diff. Dec., 1956-1955	TOTAL PRODUCTION 1956	1955	% Diff. 1956-1955
Alabama	11.0	11.2	4.3	+155.8	3,012	1,411	+113.5
Arkansas	78.1	78.6	74.3	+ 5.1	28,861	28,369	+ 1.7
California	948.4	950.8	979.1	— 3.1	351,576	354,812	— 0.9
Colorado	139.0	155.7	155.9	— 10.9	58,532	52,653	+ 11.2
Florida	1.3	1.3	1.4	— 7.2	481	495	— 2.8
Illinois	238.2	236.3	227.5	+ 4.7	83,001	81,423	+ 1.9
Indiana	32.6	31.9	29.3	+ 11.3	11,249	10,988	+ 2.4
Kansas	338.4	331.9	336.0	+ 0.7	123,998	121,669	+ 1.9
Kentucky	47.2	46.7	40.3	+ 17.1	17,453	15,518	+ 2.5
Louisiana	970.1	843.7	771.8	+ 25.7	298,902	271,010	+ 10.3
North Louisiana	131.1	126.4	116.6	+ 12.4	46,435	43,601	+ 6.5
South Louisiana	839.0	717.3	655.2	+ 28.1	252,467	227,409	+ 11.0
Michigan	27.7	28.6	30.3	— 8.6	10,847	11,266	— 3.7
Mississippi	114.3	114.0	112.2	+ 1.9	40,679	37,741	+ 7.8
Missouri	0.2	0.2	0.2	.....	56	72	— 22.2
Montana	68.5	66.3	44.4	+ 54.3	21,676	15,654	+ 38.5
Nebraska	38.6	38.6	28.3	+ 36.4	15,628	11,203	+ 39.5
Nevada	0.1	0.2	0.3	— 66.7	65	64	+ 1.5
New Mexico	243.7	241.9	228.6	+ 2.9	87,662	82,958	+ 5.7
Southeast New Mexico	241.7	240.0	227.1	+ 6.4	86,396	81,941	+ 5.4
Northwest New Mexico	2.0	1.9	1.5	+ 33.3	1,266	1,017	+ 24.5
New York	7.5	7.7	10.6	— 29.3	2,757	2,904	+ 5.1
North Dakota	38.0	38.0	35.9	+ 5.8	13,281	11,141	+ 19.1
Ohio	12.3	12.9	12.9	— 4.7	4,760	4,353	+ 9.3
Oklahoma	609.4	571.6	584.9	+ 4.2	214,999	202,817	+ 6.1
Pennsylvania	21.9	22.7	19.2	+ 14.1	8,237	8,531	— 3.5
South Dakota	0.1	0.1	0.1	.....	33	30	+ 1.0
Tennessee	0.1	0.1	0.1	.....	16	13	+ 23.1
Texas	3,059.2	3,005.7	2,936.8	+ 4.2	1,110,161	1,053,297	+ 5.4
Dist. 1 South Central	56.0	57.4	56.5	— 0.8	20,145	18,823	+ 7.0
Dist. 2 Middle Gulf	153.4	153.2	162.1	— 5.4	56,891	55,436	+ 2.6
Dist. 3 Upper Gulf	457.9	444.7	439.5	+ 4.2	165,421	163,799	+ 0.9
Dist. 4 Lower Gulf-S.W.	236.6	232.0	246.4	— 3.9	88,553	89,034	— 0.5
Dist. 5 East Central	39.8	39.4	49.5	— 19.6	16,064	17,740	— 9.5
Dist. 6 Northeast	341.3	332.6	354.9	— 3.8	124,798	126,132	— 1.1
Dist. 7-B North Central	159.2	155.2	150.0	+ 6.1	57,360	52,384	+ 9.5
Dist. 7-C West Central	170.0	175.6	179.2	— 5.1	66,804	66,296	+ 0.8
Dist. 8 West	1,130.5	1,100.1	992.4	+ 13.9	387,096	343,777	+ 12.6
Dist. 9 North	208.5	210.4	216.4	— 3.7	77,228	73,594	+ 4.9
Dist. 10 Panhandle	105.9	105.1	90.2	+ 17.4	35,857	32,328	+ 10.9
Utah	8.6	8.2	4.7	+ 82.9	2,304	2,227	+ 3.5
Virginia	0.1	0.1	0.1	.....	14	12	+ 16.7
West Virginia	5.3	5.8	6.2	— 14.5	2,178	2,320	— 6.1
Wyoming	296.2	285.7	279.7	+ 5.9	104,958	99,483	+ 5.5
Total United States	7,376.0	7,136.5	6,954.7	+ 6.1	2,617,376	2,484,428	+ 5.4

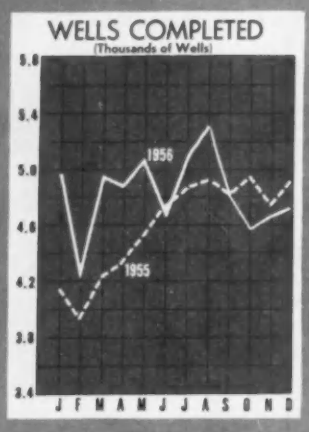
U. S. Crude Oil and Refined Product Trends

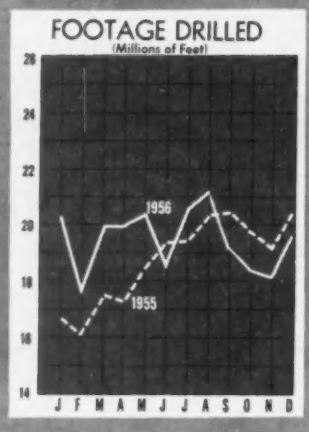
(THOUSANDS OF BARRELS)

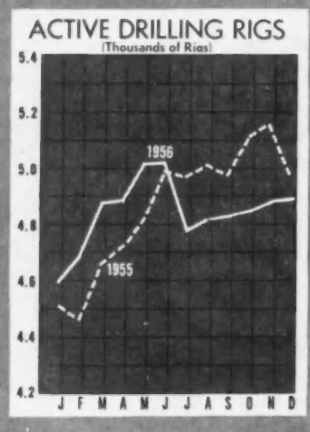
MONTH	CRUDE OIL Production Daily	Runs to Stills Daily	Stocks End of Month	GASOLINE Production Daily	Stocks End of Month	DISTILLATE FUEL Production Daily	Stocks End of Month	RESIDUAL FUEL Production Daily	Stocks End of Month	DAILY IMPORTS Crude Oil	Total Oils
1955:											
April	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	1,621	143,248	1,061	46,267	829	1,218
October	6,831	7,465	267,346	3,827	153,103	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	1,765	111,333	1,286	39,174	884	1,502
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	1,772	158,871	1,082	48,400	1,004	1,541
November	7,137	8,027	275,910	3,825	175,405	1,822	153,384	1,183	44,376	881	1,323
December	7,376	8,114	263,027	3,959	186,374	1,990	133,742	1,283	42,696	864	1,453
Week Ended:											
1-11-57	7,396	8,272	259,657	3,954	189,243	2,056	122,983	1,331	42,727	961	1,683
1-13-56	7,014	7,949	259,188	3,835	171,906	1,934	101,074	1,311	39,325	843	1,465

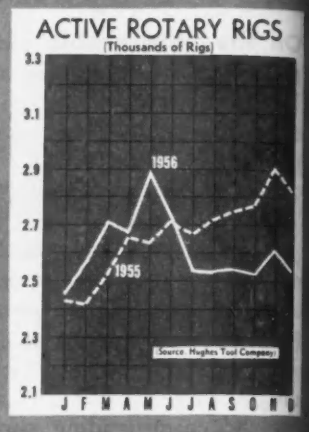
Source: Data for last two months from API; prior monthly data from Bureau of Mines.

Drilling Activities . . .









1956's Wells Hit New Peak Of 58,206, 4% Over 1955

By CECIL W. SMITH, WORLD OIL Staff

LAST YEAR was the most active drilling year in history and the seventh consecutive period that saw a new drilling record set. Despite setbacks caused by pipe shortages in the latter months, the nation's drillers finished the year with 58,206 wells, 4 percent more than the previous peak drilled in 1955.

The outlook for this year is even brighter. The industry might be expected to drill as many wells as it would have if the steel strike had not occurred. With greater supplies of tubular goods making it possible, and the recent crude price hike making it economically attractive, the 59,000-well level is a definite possibility for 1957.

One of the big questions at this point is whether the price increase can hold. There can be no question that the well deserved, and long overdue, price boost is necessary to keep the domestic industry strong and vitalized in its development of the nation's reserves. But, this hike had a somewhat artificial flavor, and, unfortunately, was not based on sounder economics as have been past increases. Many fear that resumption of normal trade that will come with the reopening of the Suez Canal will "pull the rug" from under the new price structure.

Little improvement in drilling rates was experienced during December. More wells were completed during the month, as could be expected, than were drilled in November, but practically no headway in the number of active drilling rigs was made. On a daily average basis, December's wells actually were slightly fewer than the previous month's.

Despite the substantial cutback that became evident in September's statistics, the year ended with a new high of 58,206 new wells. That was 2327 wells, or 4.2 percent, greater than the 55,879-well peak reached in 1955.

Of importance to the industry is the number of wells drilled, but a better measure of the amount of work crammed into a year is the footage drilled. In this department, a new record was also set, but percentage-wise the increase did not match that of the wells. A total of 235,221,293 feet of hole topped the 228,529,688 feet recorded in 1955 by only 2.9 percent, while the wells had an advantage of 4.2.

Average well depth amounted to almost 50 feet shallower in 1956 than 1955's, being 4041 feet compared with the previous period's 4090 feet. The year's average trailed its predecessor from the start. At the halfway mark, wells had averaged 4067. The third quarter, beset with pipe problems, saw well depth drop to 4010 feet. The final quarter saw some increase as the average rose to 4028 feet, still far from the previous year's mark.

Summary of U. S. Wildcat Drilling

ITEM	Dec., 1956	Nov., 1956	TWELVE MONTHS January-December 1956	1955	Percent Diff.
Oil	81	70	1,055	1,085	— 2.8
Distillate	9	10	110	123	—10.6
Gas	21	18	259	236	+ 9.7
Total Discoveries	111	98	1,424	1,444	— 1.4
Dry Wildcats	921	921	11,150	10,157	+ 9.8
Total Wildcats	1,032	1,019	12,574	11,601	+ 8.4
Percent Productive	10.8	9.6	11.4	12.4	.....
Percent Dry	89.2	90.4	88.6	87.6	.....

(See Page 72 for details)

Summary of U. S. Drilling Activity

ITEM	Dec., 1956	Nov., 1956	TWELVE MONTHS January-December 1956	1955	Percent Diff.
New Wells Completed:					
Oil	2,349	2,331	30,528	30,474	+ 0.2
Distillate	40	42	551	709	—22.3
Gas	333	331	3,980	3,460	+15.0
Service	94	127	1,036	672	+54.2
Dry	1,906	1,789	22,111	20,564	+ 7.5
Total Wells	4,722	4,620	58,206	55,879	+ 4.2
Footage Drilled (Mln. of Feet)	19.8	18.0	235.2	228.5	+ 2.9

(See Page 72 for details)

Sharp eyes follow your Bethlehem drop forging

No need to point out that the making of a good drop forging requires sharp eyes. But at Bethlehem, we like to feel that the eyes are a little sharper than usual. That's just a way of saying every operation is watched with particular care.

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Bethlehem offers a thoroughly integrated set-up, one that produces a huge variety of drop-forge designs. Every aspect of the service is strictly first-class. If care and alertness are extras that you value, it will be to your advantage to call us.

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U. S. Drilling Activity in December and Total Years, 1956-1955

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR DECEMBER, 1956 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Dec., 1956	Nov., 1956	Dec., 1955	Total Footage December, 1956	DETAILS FOR YEAR — NEW WELLS — 1956	1955	Percent Diff.	FOOTAGE — 1956	1955	WILDCAT DRILLING IN DECEMBER AND TOTAL YEARS 1956-1955: DETAILS FOR DEC., 1956 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR YEAR — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1956	1955	DRILLING RIGS IN OPERATION — Dec. 31, 1956	Nov. 30, 1956	Dec. 31, 1955
Alabama	2	....	....	1	....	3	11	4	29,623	90	43	+109.3	769,685	204,191	....	....	....	1	1	....	....	2	25	27	41	25	16	9
Arizona	....	....	....	....	....	....	....	....	....	7	5	+ 40.0	22,048	22,5178	....	....	....	....	....	....	....	2	5	7	5	1	1	....
Arkansas	65	....	2	40	....	107	103	48	310,007	1,025	784	+ 30.7	3,055,699	2,530,207	....	....	....	16	16	11	....	4	136	151	151	80	77	45
California	156	....	2	49	....	207	201	177	829,511	2,201	2,469	— 10.9	10,030,280	12,141,529	1	....	....	28	29	13	....	7	273	293	388	208	190	213
Colorado	11	....	2	88	....	101	100	120	527,632	1,265	1,520	— 16.8	6,511,406	8,208,324	1	....	....	70	71	26	1	14	654	695	801	67	69	82
Florida	....	....	....	1	....	1	1	1	12,512	14	26	— 46.2	94,819	179,185	....	....	....	1	1	....	....	....	14	14	25	2	2	3
Georgia	....	....	....	....	....	....	....	....	....	7	2	+250.0	30,149	9,305	....	....	....	....	....	....	....	....	7	7	2	1	1	2
Idaho	....	....	....	....	....	....	....	....	....	1	7	— 85.7	4,528	19,780	....	....	....	....	....	....	....	....	1	1	7	....	....	....
Illinois	84	....	6	145	..	235	257	404	544,400	3,650	3,908	— 6.6	8,412,685	9,449,165	....	....	....	....	....	17	....	1	941	959	771	232	266	282
Indiana	23	....	1	34	....	58	84	37	102,907	707	634	+ 11.5	1,230,690	1,006,909	1	....	....	16	17	6	....	....	178	184	185	100	109	99
Kansas	157	....	25	166	7	355	402	414	1,278,138	4,643	4,669	— 0.6	16,448,860	17,605,365	6	....	1	72	79	150	....	41	1,022	1,213	1,193	553	548	486
Kentucky	58	....	18	72	1	149	137	167	247,882	1,866	1,782	+ 4.7	2,800,531	2,707,978	4	....	....	2	6	10	....	....	130	140	162	110	120	121
Louisiana	192	5	51	145	....	393	309	412	3,123,503	3,803	4,293	— 11.4	27,985,517	28,417,781	6	3	3	59	71	50	31	20	577	678	580	424	421	406
North Louisiana	76	1	19	48	....	144	154	206	555,580	1,651	2,151	— 23.3	5,990,513	6,829,597	..	1	....	13	14	13	3	2	212	230	221	69	72	73
South Louisiana	116	4	32	97	....	249	155	206	2,567,923	2,152	2,142	+ 0.5	21,995,004	21,588,184	6	2	3	46	57	37	28	18	365	448	359	355	349	333
*Gulf of Mexico	35	1	4	12	....	52	32	43	512,131	446	360	+ 18.1	4,263,784	3,559,274	2	1	1	3	7	8	7	6	49	70	71	89	74	64
Maryland	....	....	....	....	....	....	....	....	....	4	11	— 63.6	30,716	50,321	....	....	....	....	....	....	....	....	....	....	1	1	1	....
Michigan	19	....	....	21	....	40	31	35	131,379	438	512	— 14.5	1,268,400	1,524,610	1	....	....	17	18	5	....	2	152	159	197	69	73	83
Mississippi	9	....	....	31	....	40	33	38	295,295	435	462	— 5.9	3,145,761	3,370,283	1	....	....	21	22	12	2	....	191	205	192	32	41	43
Missouri	....	....	....	....	....	....	....	1	....	25	25	....	27,153	13,696	....	....	....	....	....	....	....	....	16	16	18	1	1	2
Montana	16	....	....	24	....	40	49	24	198,101	503	363	+ 38.6	2,490,947	1,746,638	1	....	....	19	20	9	....	2	196	207	153	46	59	45
Nebraska	11	....	....	36	....	47	50	68	279,096	888	847	+ 4.8	5,147,753	4,844,139	2	....	....	18	20	41	....	1	385	427	386	31	28	39
Nevada	....	....	....	....	....	....	1	....	....	6	6	....	36,613	44,828	....	....	....	....	....	....	....	....	4	4	4	3	4	5
New Mexico	72	1	40	37	....	150	171	138	658,527	1,967	1,726	+ 14.0	8,744,835	7,354,782	2	1	....	22	25	44	2	1	237	284	209	173	162	167
New York	15	....	3	3	24	45	76	30	75,000	517	402	+ 28.6	759,200	619,097	....	....	....	....	....	....	....	....	....	....	13	68	78	48
North Dakota	18	....	....	6	....	24	16	16	180,528	280	253	+ 10.7	2,078,821	1,794,669	1	....	....	5	6	10	....	....	74	84	67	26	31	26
Ohio	42	....	15	29	....	86	79	117	197,878	1,026	1,214	— 15.5	2,461,960	2,547,752	....	....	....	....	....	....	....	....	3	3	16	205	228	212
Oklahoma	282	2	18	178	23	503	555	581	1,730,249	7,642	7,605	+ 0.5	27,135,586	26,464,766	10	1	1	49	61	103	16	33	662	814	777	570	572	684
Oregon	....	....	....	....	....	....	....	....	....	1	5	— 80.0	12,880	27,278	....	....	....	....	....	....	....	....	1	1	5	....	....	....
Pennsylvania	32	....	21	4	34	91	112	75	227,878	954	761	+ 25.4	2,530,628	1,837,578	....	....	1	....	1	....	....	8	1	9	12	184	198	120
South Dakota	....	....	....	1	....	1	3	....	3,450	21	12	+ 75.0	71,164	52,476	....	....	....	1	1	....	....	....	20	20	12	6	7	2
Tennessee	....	....	....	....	....	....	....	....	....	30	31	— 3.2	39,300	41,240	....	....	....	....	....	....	....	....	30	30	27	....	....	....
Texas	1,016	32	78	708	5	1,839	1,705	1,922	8,052,081	22,361	19,953	+ 12.1	95,021,813	87,565,959	43	4	10	462	519	532	56	97	4,861	5,546	4,860	1,347	1,261	1,472
Dist. 1: South Central	61	....	2	68	....	131	142	126	300,728	1,994	1,772	+ 12.5	5,084,305	4,708,002	2	....	1	58	61	23	1	6	545	575	435	46	34	47
Dist. 2: Middle Gulf	21	5	8	30	....	64	54	63	403,985	814	823	— 1.1	5,007,110	5,022,314	....	1	2	25	28	14	9	9	245	277	313	48	40	42
Dist. 3: Upper Gulf	61	17	10	68	....	156	163	164	1,132,956	1,827	1,789	+ 2.1	12,541,644	11,552,991	1	2	1	40	44	20	13	6	450	489	463	149	156	136
*Gulf of Mexico	....	1	....	3	....	4	3	....	34,603	20	14	+ 42.9	196,685	137,881	....	....	....	3	3	....	....	....	15	15	8	5	4	4
Dist. 4: Lower Gulf-S.W	39	10	13	55	....	117	122	129	610,949	1,450	1,351	+ 7.3	7,565,442	7,192,881	3	1	1	40	45	24	21	20	441	506	470	83	83	73
*Gulf of Mexico	....	1	....	1	....	2	1	....	14,743	13	12	+ 8.3	111,841	115,549	....	....	....	1	1	....	....	....	2	2	6	2	2	3
Dist. 5: East Central	....	....	....	16	....	16	20	42	73,364	241	281	— 14.2	868,129	1,102,078	....	....	....	15	15	....	....	....	146	146	147	12	11	13
Dist. 6: Northeast	71	....	8	31	....	110	74	71	591,660	964	754	+ 27.9	5,173,418	3,997,867	1	....	....	14	15	14	1	4	217	236	199	70	77	76
Dist. 7-B: North Central	113	....	4	144	....	261	205	266	864,718	3,024	3,127	— 3.3	10,721,046	10,184,060	11	....	2	105	118	159	....	17	987	1,163	1,107	125	104	173
Dist. 7-C: West Central	57	....	2	25	....	84	67	159	372,333	1,228	1,234	— 0.5	5,600,837	6,524,959	6	....	2	17	25	48	....	5	276	329	356	104	94	123
Dist. 8: West	361	....	4	64	1	430	365	538	2,274,496	4,364	4,106	+ 6.3	22,470,236	21,864,008	9	....	1	34	44	103	3	3	417	526	530	344	343	438
Dist. 9: North	164	....	4	194	4	366	391	277	1,004,571	5,058	3,741	+ 35.2	14,453,187	11,954,252	9	....	....	106	115	106	2	8	1,043	1,159	781	258	212	257
Dist. 10: Panhandle	68	....	23	13	....	104	102	87	422,321	1,397	975	+ 43.3	5,536,459	3,462,547	1	....	....	8	9	21	6	19	94	140	59	108	107	94
Utah	3	....	3	6	....	12	19	8	67,169	146	101	+ 44.6	694,502	445,055	....	....	....	7	7	6	....	3	83	92	86	38	31	29
Virginia	....	....	....	....	....	....	....	....	....	20	24	— 16.7	90,000	108,556	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Washington	....	....	....	....	....	....	....	....	....	1	8	— 87.5	7,493	37,792	....	....	....	....	....	....	....	....	1	1	8	....	....	....
West Virginia	5	....	44	14	....	63	48	49	181,550	698	639	+ 9.2	1,902,460	1,683,815	....	....	4	1	5	....	....	16	15	31	21	196	195	168
Wyoming	61	....	4	67	....	132	67	40	478,734	964	777	+ 24.1	4,126,411	3,852,121	1	....	1	34	36	10	2	5	255	272	226	86	92	94
Total United States	2,349	40	333	1,906	94	4,722	4,620	4,926	19,763,030	58,206	55,879	+ 4.2	235,221,293	228,529,688	81	9	21	921	1,032	1,055	110	259	11,150	12,574	11,601	4,885	4,882	4,987
Total Western Canada	247	....	13	48	....	308	480	224	1,476,820	3,391	2,766	+ 22.6	15,869,656	12,137,850	....	....	....	....	....	....	....	....	....	....	....	229	222	206

*Gulf of Mexico wells are included in their respective District totals.

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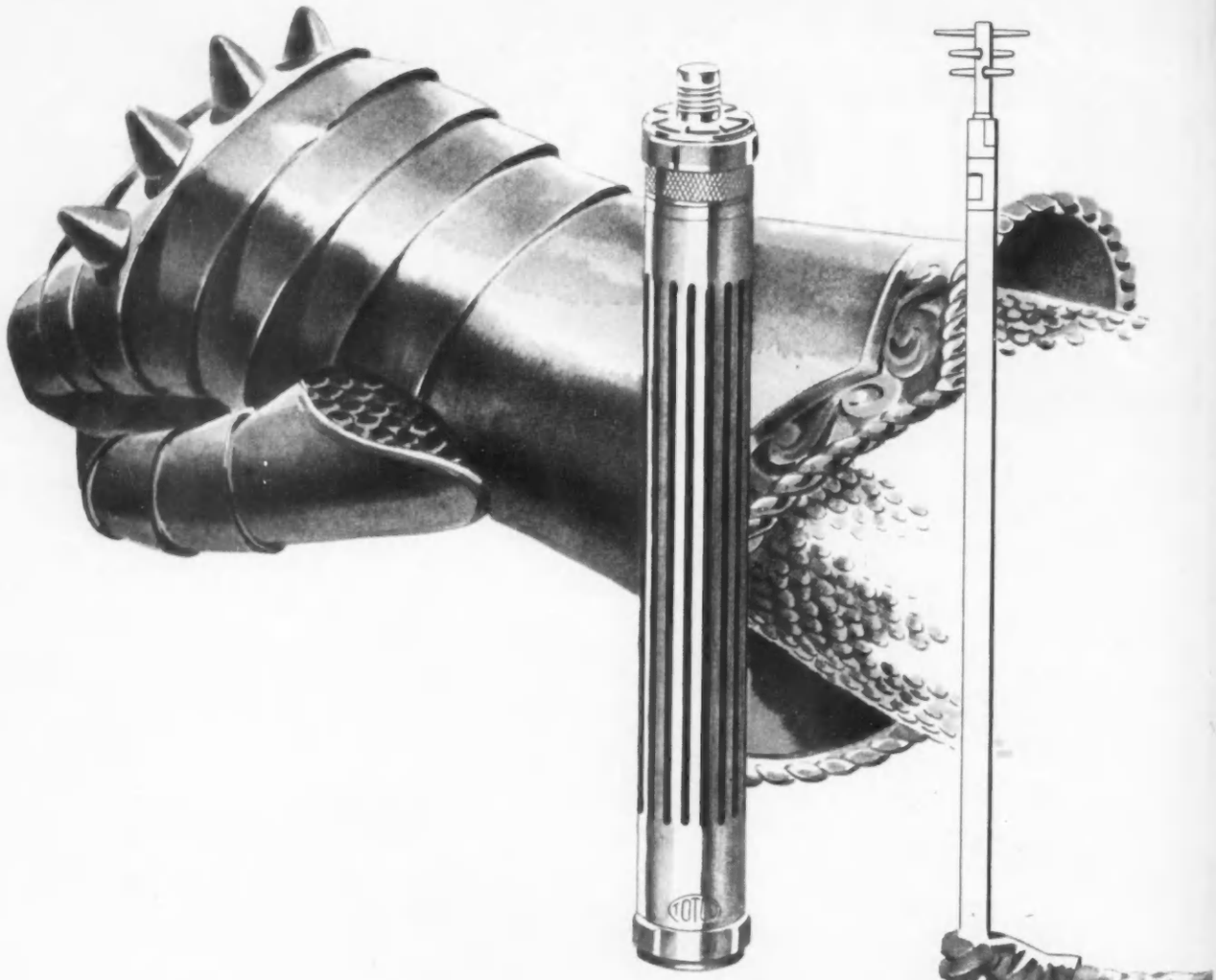

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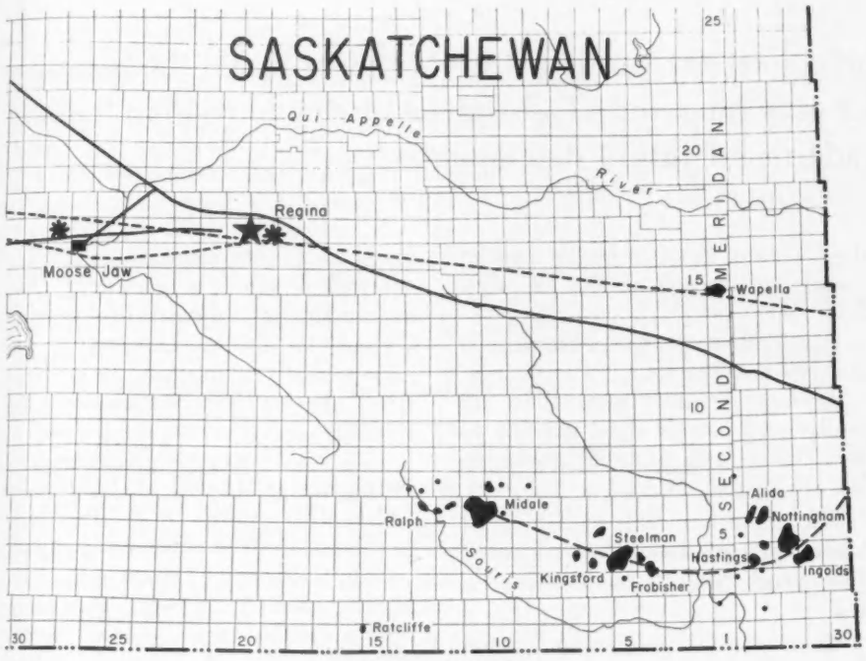


High Success Rate Spurs Saskatchewan Development

About 15 operators are now actively developing this highly productive area. Thus far, approximately 42,000 acres have been proven and recoverable reserves are estimated to be 356,500,000 barrels.

AN UNUSUALLY HIGH discovery ratio, considerably higher than the national average, good gravity crude and a recently opened pipe line outlet, all have combined to mark a 50- by 125-mile area in Southeastern Saskatchewan as the most active and promising sector in that province.

Numerous separate pools, many of them by no means fully developed extend in a gentle east-west arc in the extreme southeast corner of the province, only a few miles from the North Dakota border. The original discovery in the area, was Socony-Central Leduc- Del Rio Ratcliff No. 1, completed in November, 1952. The discovery which sparked the present boom, however, is considered to be Canadian Gulf's Quinn No. 9, near Frobisher, which was completed in March, 1954, for an initial potential of 100 barrels per day of 38-gravity oil.

Production in that area recently pumped from 13,000 to 20,000 barrels per day when the new Westspur pipe line was completed, tying the area in with Interprovincial pipe line near Cromer, Manitoba. A continuing spectacular wildcat success rate assures a continuing and rapid increase in reserves in the region.

Seismic, gravity and sub-surface surveys all have been credited with the high discovery rate.

To date there have been some 480 wells completed in the sector. Total proven acreage so far amounts to about 42,000 acres. Acreage proven but undrilled is estimated at about 21,000 acres. At present, some 70 rigs are running in the area, with the number still on the increase.

Approximately 15 operators are active. Principal leaseholders include Imperial Oil, Husky Oil and Refining, Anglo-American Exploration, Mobil Oil of Canada, Shell, British-American, Canadian Delhi.

Future outlook of the area remains good, with high discovery rate encouraging continued all-out drilling and assuring greater production and numerous field extensions. A high percentage of the wells are wildcats. Leases bring top Saskatchewan prices, though less than in Alberta, generally speaking.

Proven recoverable reserves in the area are estimated at 356,500,000 barrels.

Geology, Typical Producing Conditions. Typical structures in the area are stratigraphic traps.

Principal producing formations are the Charles, at 4400 feet, and Mission Canyon, at 4500 feet, both being Mississippian in age.

Development pattern being followed is based on 80-acre spacing.

Maximum daily allowable per well is 60 barrels. Current total production is in the order of 20,000 barrels

Continued on Page 80

Pembina Field Is Still Expanding

Outlook is extremely good for continued development inside the presently known area. Spotted occurrence of Viking and Mississippian production within the field also lend encouragement for additional future development.

PEMBINA, CANADA'S largest oil field which is still in the development and new extension stage, is already accounting for about one fourth of Alberta's total production. The Pembina field was discovered by Mobil Oil of Canada in their Socony-Seaboard-Pembina No. 1 and completed in May, 1953 for an intial production of 200 barrels per day.

Centered some 75 miles southwest of Edmonton in gently rolling foothills, the field still is far from being fully developed. The discovery well was drilled on a seismic feature which proved insignificant but which led eventually to the Cardium oil strike based on sub-surface geology.

Some 1400 wells have been drilled thus far on approximately 100,000 acres. Development and exploratory operations are continuing steadily with all available rigs. At present, some 60 to 80 rigs are operating in the area. Acreage proven but still undrilled is estimated at plus or minus 400,000 acres.

Approximately 20 operators are active. Among principal leaseholders are Mobil Oil, Stanolind Oil and Gas Company, Sinclair Oil Corporation, Hudson's Bay, Phillips Petroleum Company, Home Oil, Imperial Oil Company, Canadian Gulf Oil Company, Texas Exploration Co., Merrill Petroleum, Standard Oil Company of California, Ohio Oil Co., Great Plains Development Co. of Canada, Ltd., and Tennessee Gas Transmission Company.

Reserve estimates of the Cardium sand pay currently are believed to be in excess of one billion barrels. Secondary recovery, flooding with hot water now getting underway on a pilot flood basis, is expected to boost recoverable reserves prospects.

Geology, Typical Producing Conditions. Structure is a stratigraphic trap. Principal producing formation is the Cardium Sand of Cretaceous age found at average depths of about 5200 feet.

Development pattern is based on 80 and 160-acre spacing.

Average prorated production currently is 72 barrels of oil per day per well. Over half of wells completed still are flowing naturally.

Maximum allowable in field is 200 barrels per day for 160-acre spacing; 140 barrels per day on 80-acre spacing.

Current total production for field is between 100,000 and 120,000 barrels per day.

Crude is sweet, averages 38 gravity.

Pipe line outlet delivers crude to Edmonton for refining or connection with other pipe line systems.

Drilling and Completion Programs. Typical casing program is 10¾ to 600 feet; 5½, or 7-inch, oil string to total depth.

Drill collar program in the order of thirteen 6¼-inch collars in 8¾-inch hole.

Typical bit consumption per well is one 13¾-inch for surface hole and 12 to 14 8¾-inch bits for remainder of hole.

Purchased mud is used. Some blowout trouble is encountered at shallow depths before surface pipe is set but, beyond that, no appreciable difficulties and mud control not critical.

Drilling rate, typical, is fast and easy.

No cementing problems of importance are encountered.

Typical rotary speeds average around 400 revolutions per minute; usual weight on bit around 30,000 pounds.

Wells usually cased, perforated opposite pay interval and fractured; wells usually acidized, also.

Rigging-up time, from moving off to spudding-in, averages 1½ days, depending upon road conditions. During winter, when muskeg frozen, moving is faster and less expensive.

Average completion time from spudding to production in the tanks is 16 days.

Equipment Used. Medium-sized, jack-knife type rigs most commonly employed in field. Internal combustion engines, using diesel fuel principally, used for power. Two mud pumps usually employed; one for circulating; other for standby. Two blow-out preventers, on the 10¾-inch is typical of control equipment used.

One shale shaker and steel mud tanks are typical for the area.

General Information. Drilling water usually is hauled by truck from rivers and creeks in area.

Diesel fuel is readily available.

Nearest towns or supply centers: Drayton Valley (population 2500) and Violet Grove (population 1000) located within the field area.

Nearest principal machine shop and service facilities are at Edmonton.

Road conditions, depending upon weather and season, range from good to poor. Principal roads raised and graded; minor roads dirt, sometimes impassable in summer and thaw periods.

Surface terrain gently rolling, traversed by numerous creeks and rivers. Ground cover range from timber, brush and muskeg; some farmed areas.

Living conditions for crews gradually improving, though housing remains short, and usual services are few and inadequate.

Drilling cost per well ranges in the order of $60,000.

Prevailing footage rates range from $4 to $4.75, with hourly rates averaging $35 with drill pipe. —**The End**

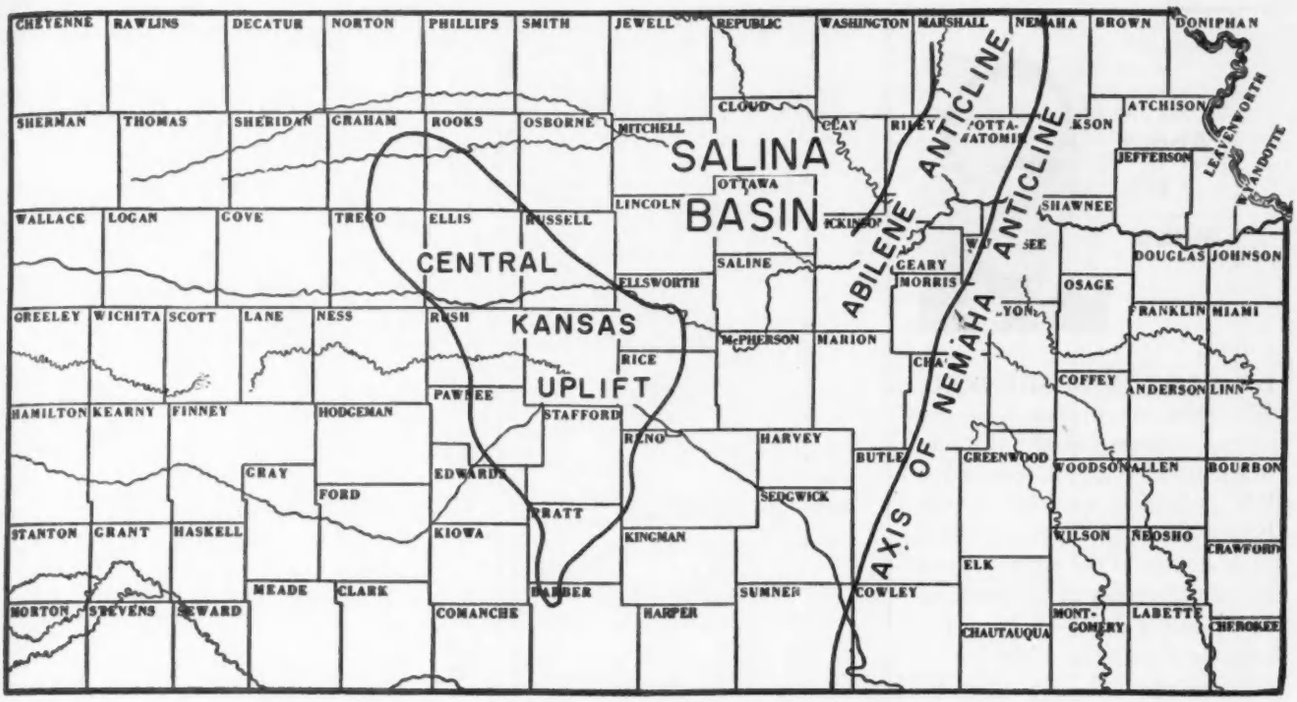


FIGURE 1—Map showing the Abilene anticline and other structural features in Kansas.

Abilene Anticline Indicates Exploration Potential

Well defined anticline fold 75 miles long offers excellent chances for successful tests on many undrilled structural features.

By CLAUDE W. SHENKEL, JR.
Kansas State College
Manhattan, Kansas

THE NORTHERN PART of the Salina basin and especially the Abilene anticline in Kansas stand at the frontier of the advancing Mid-Continent producing area. The Abilene anticline, 75 miles in length, extends from areas now producing in Kansas to the Kansas-Nebraska border. Excellent exploration potential seems to exist for the careful explorer. One who is willing to analyze and be guided by past exploration experience and who has the courage to test the unusual geological situation rather than the obvious.

Exploratory drilling to date has discovered what seems to be the most favorable geological situations for the accumulation of oil; however, commercial quantities of oil have not yet been found.

Figure 1 shows the position of the Abilene anticline and adjacent structural features. This anticline lies within the Salina basin and is subparallel to the larger Nemaha anticline. Regional west dip in surface rocks is approximately 15 feet to the mile in the vicinity of the Abilene anticline; the strong reversal of this regional dip along the axis of the anticline is easily recognized. The axis at the surface, as seen in exposed Wolfcamp rocks, is asymmetrical with gentle west dip and relatively steep dip away from the axis to the east-southeast. Figure 2 is a surface structure map of a portion of the anticline which depicts the asymmetrical nature of the fold. The structure along the entire axis is similar to the structure shown in Figure 2.

Figure 3 shows a generalized stratigraphic section for the middle part of the Abilene anticline. In the northern part of the structure, the Mississippian limestone, the Maquoketa shale, and the Arbuckle group are missing and the sedimentary rock section above the granite is only 2200 feet thick. At the southern end of the anticline the sedimentary rocks are 3100 feet thick.

Eight rock units are present in subsurface along the axis of the anticline that produce elsewhere in the Salina basin or on the Central Kansas uplift. These units are shown to the right of the generalized rock section in Figure 3.

The Abilene anticline was delineated by surface mapping in the 1920's

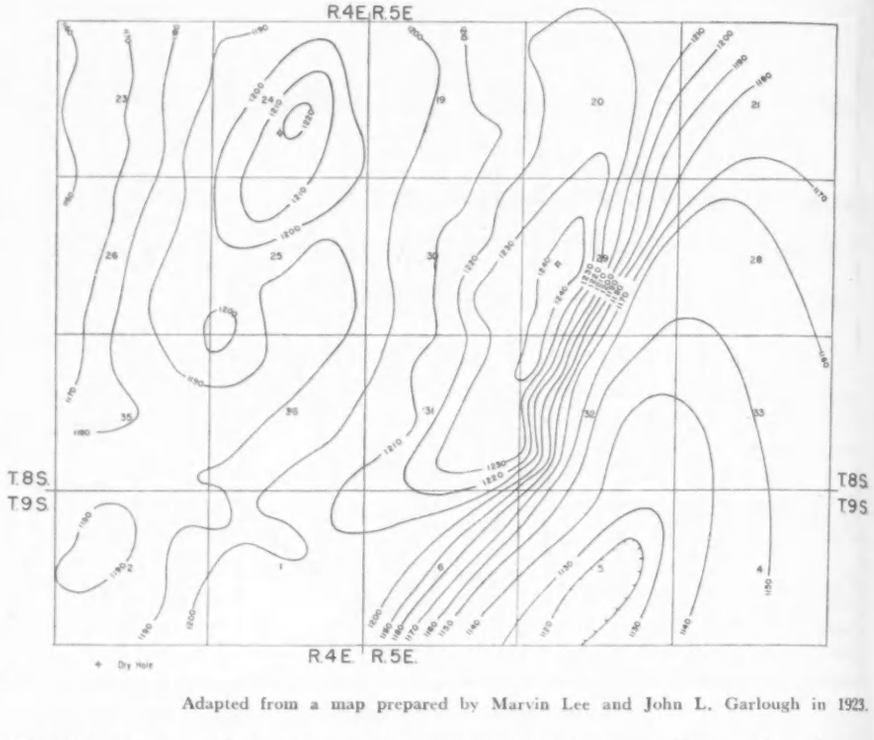
About the Author

DR. CLAUDE W. SHENKEL, JR., associate professor of geology, Kansas State College, Manhattan, Kansas, received a B.S. degree in geology at the Kansas State College in 1941; M.S. degree in the same subject at the University of Colorado in 1947; and, a doctorate from the same university in 1952.

From 1941 through 1946, he was in the U. S. Army Air Force, leaving the service with the rank of captain.

After completing his work at the University of Colorado, Shenkel served as a consultant in Colorado, Utah, New Mexico and Kansas, specializing in the fields of analysis and evaluation.

Since 1954, he has done petroleum research for the Kansas Geological Survey and acts as associate professor of geology at the University during the school year.



Adapted from a map prepared by Marvin Lee and John L. Garlough in 1923.

FIGURE 2—Surface geologic structure of a portion of the Abilene anticline in Riley County, Kansas, four miles northeast of the intersection of the anticlinal axis and the Riley-Clay county line. Contours on top of the Fort Riley Limestone, contour interval, ten feet, sea level datum.

and subsequently some wells were drilled on surface structure, but the absence of oil discouraged further exploration. In 1928 a well drilled in Sec. 21, T.9S.,R.4E., Clay County, Kansas reported some production of oil from the Pennsylvanian basal conglomerate or Mississippian "chat." Fifteen wells have since been drilled in this general area near the intersection of the anticlinal axis and the Riley-Clay county line. All wells in this area have reported shows in the Pennsylvanian basal conglomerate. On the basis of early reports this area was called the Wakefield pool; however, commercial quantities of oil have not yet been obtained from the pool. Periodically, since the 1920's additional tests have been drilled on the anticline. Since 1950 a few tests were drilled on geophysical "highs" in the southern part of the anticline but again no significant accumulation of oil was discovered. The total number of tests drilled on the anticline by January 1, 1956, was 40; however, 20 of these tests were in the Wakefield pool or adjacent to the pool.

Figure 4 shows the surface trend of the Abilene anticline, subsurface structure on the Mississippian and Hunton surfaces, and location of test holes on or near the axis of the anticline. Producing areas south of the Abilene anticline are also shown on this figure. The only good shows of oil reported are in the Wakefield pool area which is situated on the flank west of the axis of the anticline. No wells have been drilled in the area of steeper dips east of the axis of the anticline.

Figure 2 shows typical surface structure and the location of two test wells. Most of the wells drilled along the axis have been located in similar structural positions.

Structural relation between the Abilene anticline and adjacent areas is shown in Figure 4. The Abilene anticline appears to have an "en echelon" alignment with another plunging anticlinal structure, herein referred to as the Lindsborg anticline, trending northeast-southwest through Saline and McPherson counties. Figure 4 shows the areas now producing from the Viola limestone and from the Maquoketa dolomite, at the base of the Maquoketa shale, along the axis of the Lindsborg anticline. Discoveries have been advancing northward along the axis of the Lindsborg anticline in recent years.

The producing areas shown in Figure 4 in southeastern Saline County and northeastern McPherson County are from Mississippian rocks and basal Pennsylvanian rocks associated with gentle anticlines having from 20 to 60 feet of closure. The

Lost Springs pool and adjacent pools shown in northeastern Marion, southeastern Dickinson, and Morris counties produce from the basal Pennsylvanian conglomerate (Mississippian "chat"). Accumulation in these pools is primarily the result of stratigraphic entrapment.

It seems significant that the trend of producing structural traps and stratigraphic traps all point northward toward the area of the Abilene anticline.

Figure 4 also depicts the "wedge out" of the Mississippian and "Hunton" limestones along the axis of the anticline. These conditions offer possibilities for stratigraphic entrapment of oil in addition to structural entrapment in these rocks.

The following factors relative to exploration along the Abilene anticline are significant.

Favorable:

- Relatively shallow drilling depth (3100 feet maximum) to test many rock units that produce elsewhere in the Salina basin and on the Central Kansas uplift.
- A well defined anticlinal fold 75 miles in length with many structural features yet untested. Not a single test has been made in the area of strong reversal immediately east of the anticlinal axis.
- Untested stratigraphic situations that could provide for stratigraphic entrapment, especially along the northern part of the axis.
- Favorable shows in some tests in the Pennsylvanian basal conglomerate and in Mississippian rocks along the Abilene anticline.
- Producing stratigraphic and structural traps south of the Abilene anticline and associated with a similar stratigraphic environment, show definite trends of alignment with the Abilene anticline.

Unfavorable:

- Approximately 40 tests, including 20 in the restricted area of the Wakefield pool, without the dis-

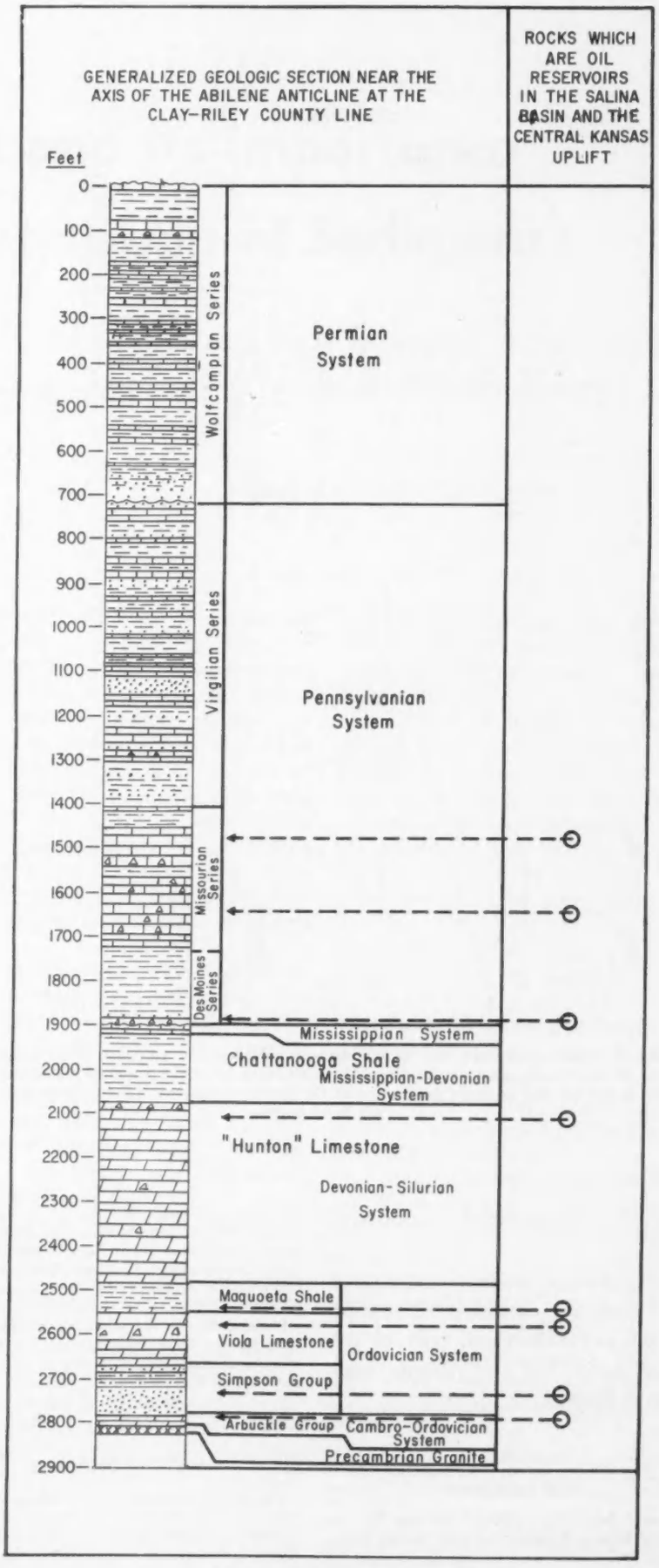


FIGURE 3.

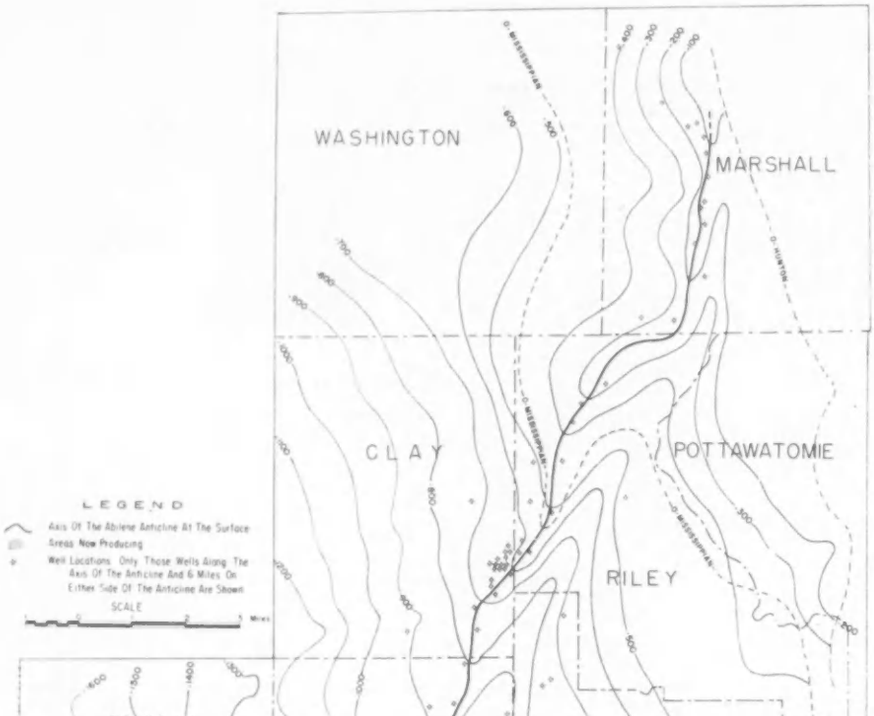


FIGURE 4—Structure contour map of the Abilene anticline and adjacent areas. Contours are on top of the Mississippian except along the northern part of the anticline where the Mississippian is missing and contours are on top of the Hunton limestone. Contour interval, 100 feet, sea level datum.

covery of commercial quantities of oil.

The geologic evidence suggests a valid basis for extensive exploration for oil in the northern part of the Salina basin and the Abilene anticline in Kansas.

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Saskatchewan Developments

Continued from Page 75

per day. Most wells are completed pumping.

Crude oil ranges from light to medium gravity and is sweet.

Typical Drilling, Completion Programs. Typical hole size is 7⅞-inch, for 5½-inch production casing.

Typical drill string program is 4½-inch drill pipe, with eight 6¼-inch drill collars.

Typical bit consumption is eight 7⅞-inch.

Natural mud is employed down to the lime, where it is changed to gypsum base mud.

No danger exists of blow-outs and no circulation problems of importance are encountered.

Drilling is relatively easy, with drilling conditions being normal. No problems are encountered in cementing.

Usual weight on bit is 20,000 pounds. Typical rotary speed 90 revolutions per minute.

Completion usually involves setting pipe through the pay, perforating, acidizing and swabbing.

Average rigging-up time, from moving off to spudding-in is 48 hours.

Average completion time, from spudding-in to production in the tanks, is 22 days.

Equipment Used. Medium size, diesel engine powered rigs are most commonly used in the area.

A single mud pump, used for both circulating and mixing, is used.

One blow-out preventer and a single shaker are typical on rigs in the region. Most ditches are excavated. Some diamond coring is done.

General Information. Drilling water is hauled from nearby sloughs.

Fuel of all kinds is available in nearby towns.

Nearest supply and service centers are at the towns of Esteven and Weyburn, Sask.

Road conditions are generally good.

Surface terrain is flat prairie country.

Living conditions for crews generally inadequate.

Drilling costs per well range from $25,000 to $35,000.

Prevailing footage rates average $4, with hourly rates in the order of $33.

—The End

Turbidity Current and Its Importance In Erosion and Deposition of Sediments

A turbidity current may be defined as a body of water carrying particles in suspension and moving through a larger body of water of different density.

By V. G. GABRIEL
Consulting Geophysicist with F. Julius Fohs
Houston

DALY (1936) WAS perhaps the first American geologist to call attention to the importance of turbidity or density currents in the evolution of many submarine canyons. During the last few years Ericson, Ewing, Heezen, Wollin, and their associates, all connected with the Lamont geological observatory, have made valuable contributions to the evaluation of turbidity currents as depositional and erosional agents in the oceanic environments.

Heezen, Ewing, and Ericson (1952) define a turbidity current as a torrent of water made by suspended sediments. Somewhat later Ericson, Ewing, Heezen, and Wollin (1955) give a more detailed definition of a turbidity current as a mass of turbid water flowing down slope under clear water because of greater density owing to sediment in suspension.

In the past and for many years in the future the search for oil will be concerned with oil source accumulations developed under shallow or moderate depth environments. To properly understand and evaluate the agents which play an important part in these environments should be of value in exploration for oil.

Recent investigations indicate that a turbidity current play an important part in erosion and deposition of sediments at least at shallow and moderate depths.

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Texas

By ROBERT ROTH
Humble Oil & Refining Company
Wichita Falls, Texas

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Because of the economic interest in the general area and because the Panhandle overlies subsurface features of orogenic origin occurring between the Rocky Mountains to the west and the Wichita-Arbuckle-Ouachita Mountains to the east, it is believed that a paleogeologic study of the area would be of interest.

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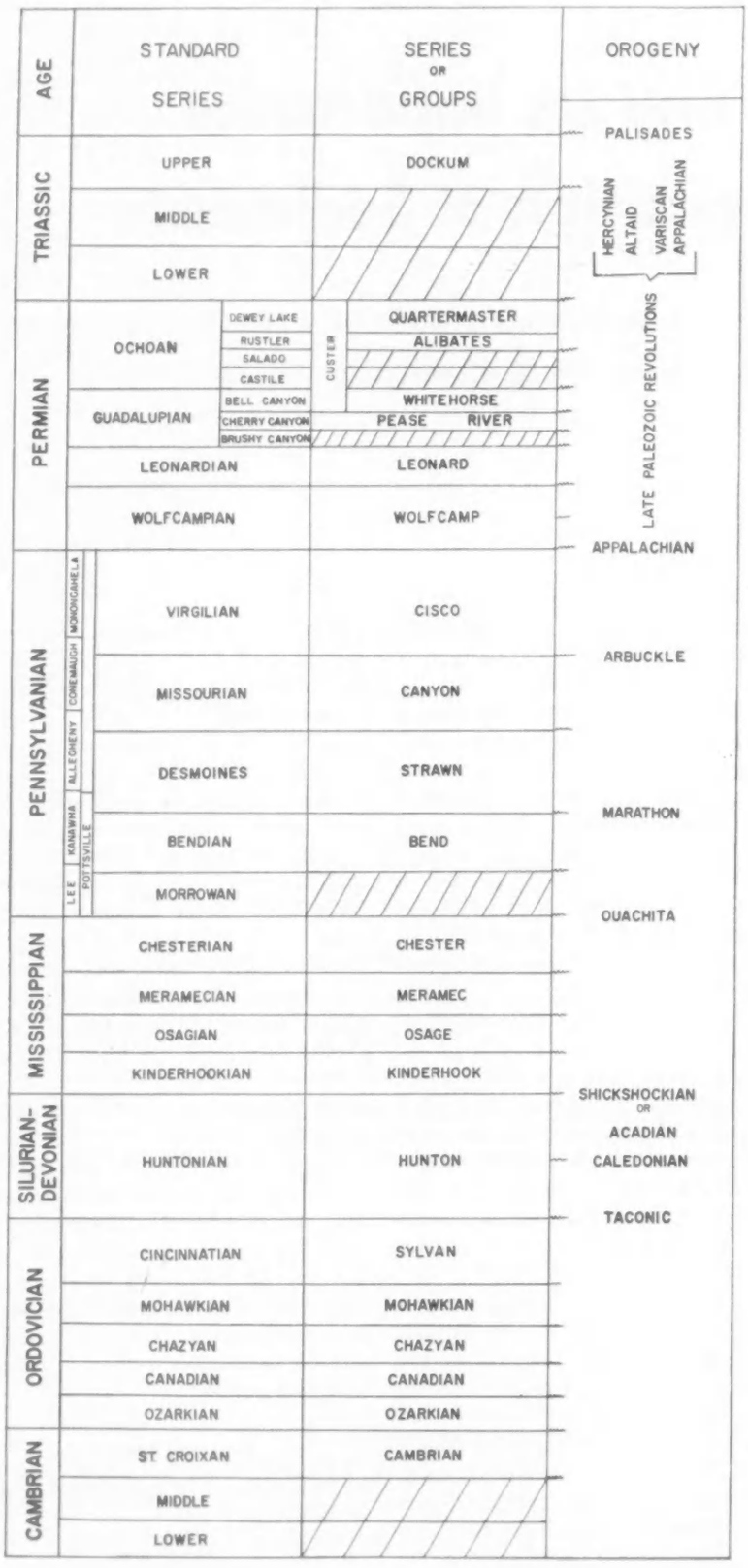

FIGURE 1—The stratigraphic column has been subdivided into 14 units. Each unit is separated from adjacent ones by a hiatus or a local unconformity. In recognizing these units, paleontology has been used where possible and comparative lithologies used where paleontology is not available. In every case time correlations with the standard sequences in established areas have been attempted. The isopachous map for each unit has been contoured on 500 foot intervals. Approximate scale: one inch equals sixteen miles.

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A younger pattern of folding has been superimposed upon the deformation outlined above and appears to be related to a late Laramide orogeny. This pattern has a north-south strike and is most noticeable in a north-south direction extending from eastern Cimarron County, Oklahoma, southward at least as far as the Bush Dome in southwestern Potter County. This uplift separates the Anadarko basin from the Dalhart basin and is called the Cimarron uplift.

Farther south in the Plainview basin this uplift is indicated by the relief of the Pre-Cambrian in the southeast corner of Castro County and by the relief under the Anton-Irish field in the southeast corner of Lamb County. Eastward from the Cimarron uplift minor north-south folds may be recognized such as those underlying the Paloduro field in southeast Sherman County and the Lipps field in north central Roberts County. That the Cimarron uplift is younger than the older orogenies may be demonstrated by several geologic facts, the simplest of these facts being the removal of the Triassic from the Pronger area in southwestern Sherman County.

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Part 1

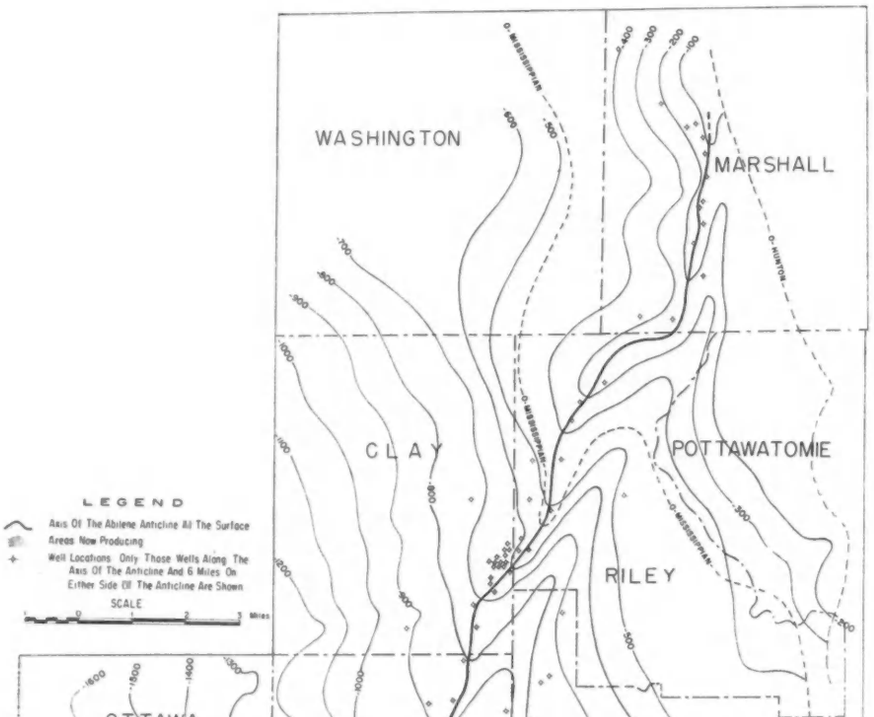

FIGURE 4—Structure contour map of the Abilene anticline and adjacent areas. Contours are on top of the Mississippian except along the northern part of the anticline where the Mississippian is missing and contours are on top of the Hunton limestone. Contour interval, 100 feet, sea level datum.

covery of commercial quantities of oil.

The geologic evidence suggests a valid basis for extensive exploration for oil in the northern part of the Salina basin and the Abilene anticline in Kansas.

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ACKNOWLEDGMENTS

This article is published in WORLD OIL with permission of the State Geological Survey of Kansas. A detailed analysis of the geology of the Abilene anticline will be published by the Kansas Geological Survey at a later date. Grateful appreciation is accorded to many oil and gas companies and independent operators in Kansas for assistance and information relative to this investigation.

Saskatchewan Developments

Continued from Page 75

per day. Most wells are completed pumping.

Crude oil ranges from light to medium gravity and is sweet.

Typical Drilling, Completion Programs. Typical hole size is 7⅞-inch, for 5½-inch production casing.

Typical drill string program is 4½-inch drill pipe, with eight 6¼-inch drill collars.

Typical bit consumption is eight 7⅞-inch.

Natural mud is employed down to the lime, where it is changed to gypsum base mud.

No danger exists of blow-outs and no circulation problems of importance are encountered.

Drilling is relatively easy, with drilling conditions being normal. No problems are encountered in cementing.

Usual weight on bit is 20,000 pounds. Typical rotary speed 90 revolutions per minute.

Completion usually involves setting pipe through the pay, perforating, acidizing and swabbing.

Average rigging-up time, from moving off to spudding-in is 48 hours.

Average completion time, from spudding-in to production in the tanks, is 22 days.

Equipment Used. Medium size, diesel engine powered rigs are most commonly used in the area.

A single mud pump, used for both circulating and mixing, is used.

One blow-out preventer and a single shaker are typical on rigs in the region. Most ditches are excavated. Some diamond coring is done.

General Information. Drilling water is hauled from nearby sloughs.

Fuel of all kinds is available in nearby towns.

Nearest supply and service centers are at the towns of Esteven and Weyburn, Sask.

Road conditions are generally good.

Surface terrain is flat prairie country.

Living conditions for crews generally inadequate.

Drilling costs per well range from $25,000 to $35,000.

Prevailing footage rates average $4, with hourly rates in the order of $33.

—The End

Turbidity Current and Its Importance In Erosion and Deposition of Sediments

A turbidity current may be defined as a body of water carrying particles in suspension and moving through a larger body of water of different density.

By V. G. GABRIEL
Consulting Geophysicist with F. Julius Fohs
Houston

DALY (1936) WAS perhaps the first American geologist to call attention to the importance of turbidity or density currents in the evolution of many submarine canyons. During the last few years Ericson, Ewing, Heezen, Wollin, and their associates, all connected with the Lamont geological observatory, have made valuable contributions to the evaluation of turbidity currents as depositional and erositional agents in the oceanic environments.

Heezen, Ewing, and Ericson (1952) define a turbidity current as a torrent of water made by suspended sediments. Somewhat later Ericson, Ewing, Heezen, and Wollin (1955) give a more detailed definition of a turbidity current as a mass of turbid water flowing down slope under clear water because of greater density owing to sediment in suspension.

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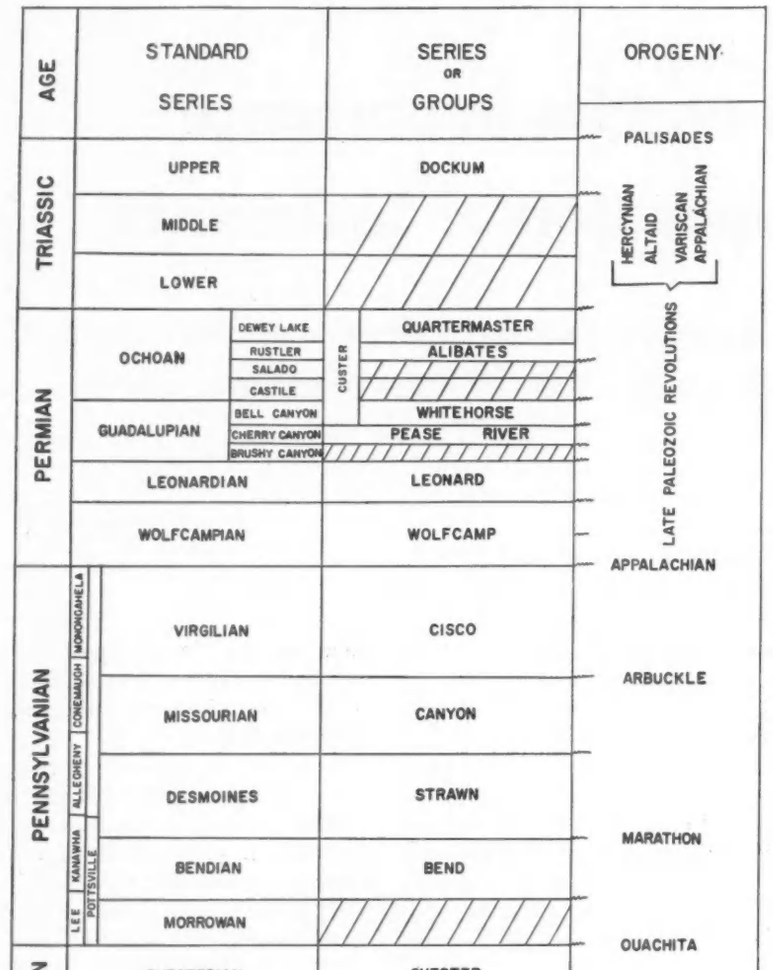

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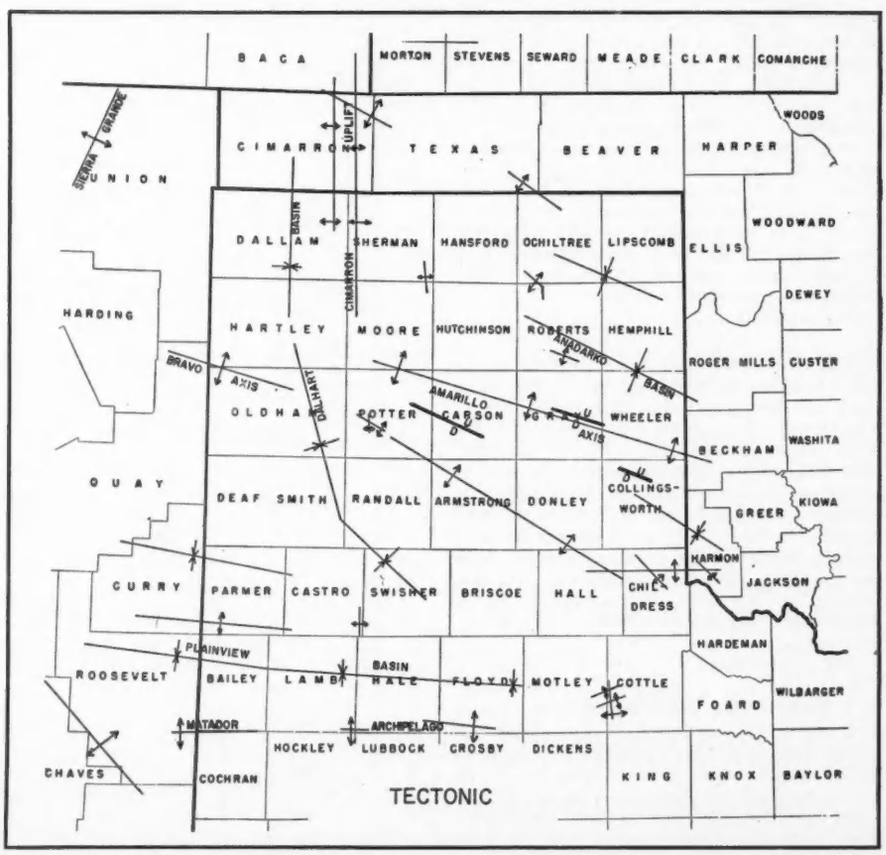

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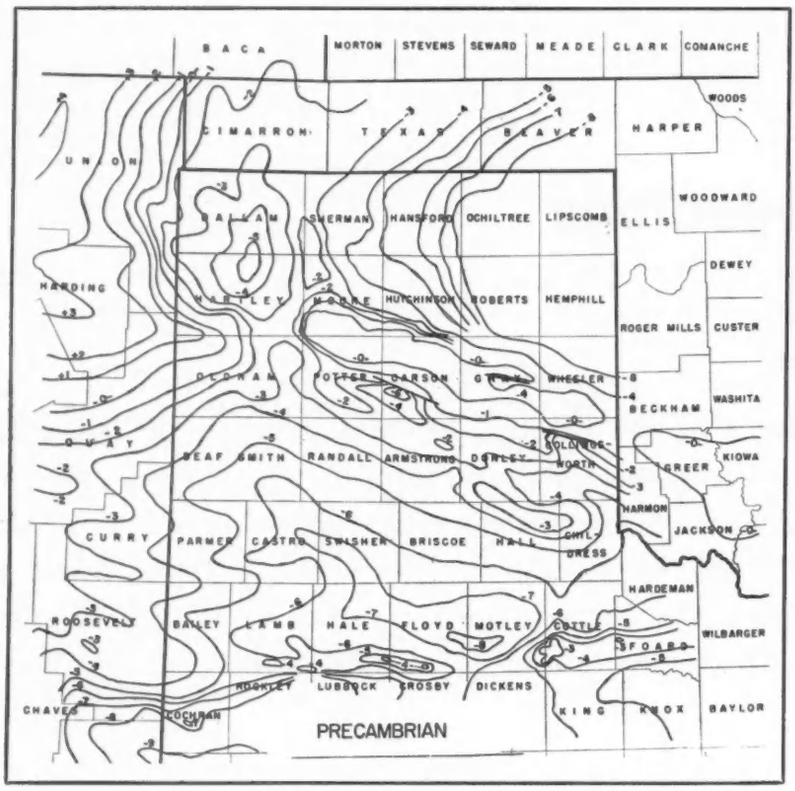

FIGURE 3—PRE-CAMBRIAN. Petrographic analyses of the rocks which underlie Cambrian sediments indicate a great variety of igneous types ranging from acidic to basic. In mode of implacement they consist of intrusive, extrusive and pyroclastic types representing different periods of activity. Certain areas have undergone dynamic metamorphism, others show hydrothermal metamorphism. A few small areas of metamorphosed Pre-Cambrian sediments are present, they are probably of Algonkian age. Weathering of the Pre-Cambrian surface is very slight where Cambrian sediments are present. This may be due to the chemical composition of the Cambrian atmosphere. It is impossible to distinguish between Pre-Cambrian and post-Cambrian igneous rocks where Cambrian sediments are absent. The topography of the Pre-Cambrian is shown on Figure 3. Contour interval: one thousand feet.

A few wells have reported production from fractured Pre-Cambrian in Wheeler County.

FIGURE 4—UPPER CAMBRIAN. Sediments representing Upper Cambrian time consists of coarsely crystalline, light-gray, buff or salmon, secondary dolomite, some crystalline limestone, and green shale. Large well-rounded quartz sand grains cemented either with limestone or dolomite sometime occur as a bed. Glauconite is common. There are a few small widely scattered areas in which the Cambrian contains some Pre-Cambrian detrital. Usually where Cambrian rocks rest on the Pre-Cambrian, the latter is only slightly weathered. Because of the uniform thickness and great areal distribution of the Cambrian, it is believed that the first invasion of the Paleozoic sea was upon a peneplain. Local orogenic movements are not recognized in the area. Age identification is based upon comparative lithologic characteristics and paleontology.

No production.

OZARKIAN—The time equivalent of the Ozarkian herein described is the Tanyard in Texas and the McKenzie Hill in Oklahoma. Sediments representing Ozarkian time consist of buff to salmon, coarsely crystalline, probably secondary dolomite, and some milky chert which is locally variegated and in places oolitic. Large frosted quartz sand grains are locally present in the dolomite; drusy vugs are common. Orogenic movements are not present in the area. Age identification is based upon comparative lithologic characteristics.

No production.

CANADIAN—Time equivalents of the Canadian may be found in the Honeycut and Gorman of Texas and the West Spring Creek to the base of the Cool Creek in Oklahoma. Sediments representing Canadian time consists of dense light-gray dolomite, sometimes lithographic and calcareous. Milky or translucent chert is quite abundant; also some thin beds of bright-green shale. Locally large frosted sand grains are present in other sediments, but never occur as a bed. As in Cambrian and Ozarkian times, there were no local orogenies. Age identification is based upon comparative lithologic characteristics.

Local production in Gray and Wheeler counties.

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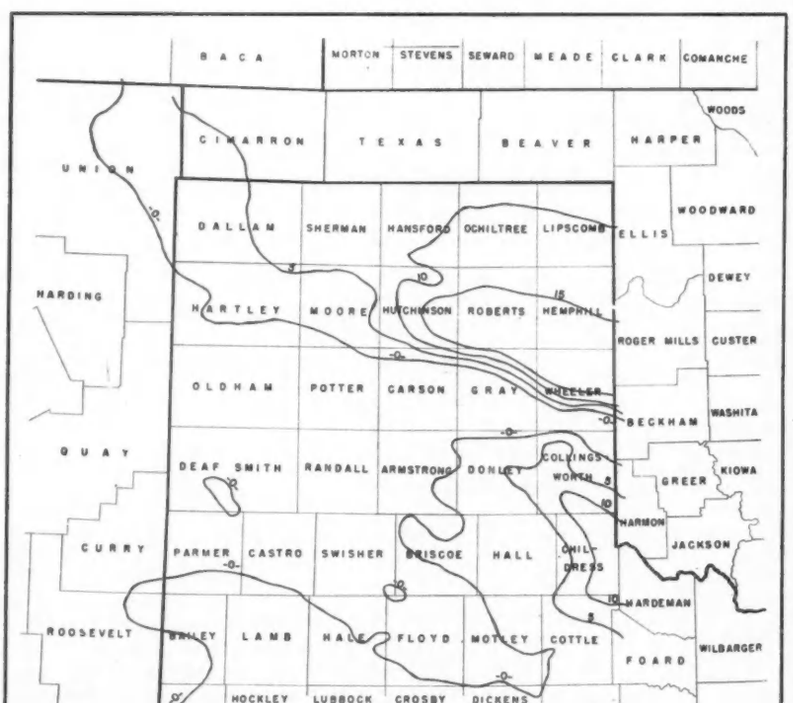

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FIGURE 5—CHAZYAN. Time equivalent of the Chazyan may be found in the interval from the base of the Black River down to the top of the West Spring Creek in Oklahoma. The Oklahoma term for the above interval is Simpson. Sediments representing Chazyan time consist of very fossiliferous, coarsely crystalline, mottled light-gray locally dolomitic limestone, and coarse to fine, well-rounded frosted quartz sand grains, usually constituting a bed. The sandstone contains abundant phosphatic nodules. There is much green shale. As stratigraphic sections are much the same whether encountered in the Anadarko basin or the Permian basin, it is evident that the Chazyan sea covered both regions. Age identification is based upon comparative lithologic characteristics and paleontology.

No production.

MOHAWKIAN—Time equivalent of the Mohawkian is to be found in the interval represented by Trenton to Black River. The above interval is usually called Viola in Oklahoma. Sediments representing Mohawkian time consist of dark-gray, crinoidal, fossiliferous limestone with much dark-gray chert, and some of the limestone and chert have a brown cast. Since detrital material is absent, no local orogenies are indicated. Age identification is based upon comparative lithologic characteristics and paleontology.

No production.

CINCINNATIAN—The time equivalent of the Cincinnatian is the Sylvan shale of Oklahoma. Sediments representing Cincinnatian time have been found only in the deepest portion of the Anadarko basin. In cuttings from a few wells, graptolites have been noted. No map is presented showing its distribution.

No production.

HUNTON—Time equivalent of the Hunton may be found in the Devonian and Silurian of Oklahoma. Sediments representing Hunton time consist of granular to crystalline, dolomitic limestone, gray to buff in color, locally containing much chert, and with an excellent local development of pink, crystalline, crinoidal, oolitic limestone, containing large well-rounded quartz sand grains in the basal portion. This oolitic limestone is equivalent in time to the Chimneyhill in Oklahoma. There is an absence of detrital from older sediments, hence no local orogenies are indicated.

No production.

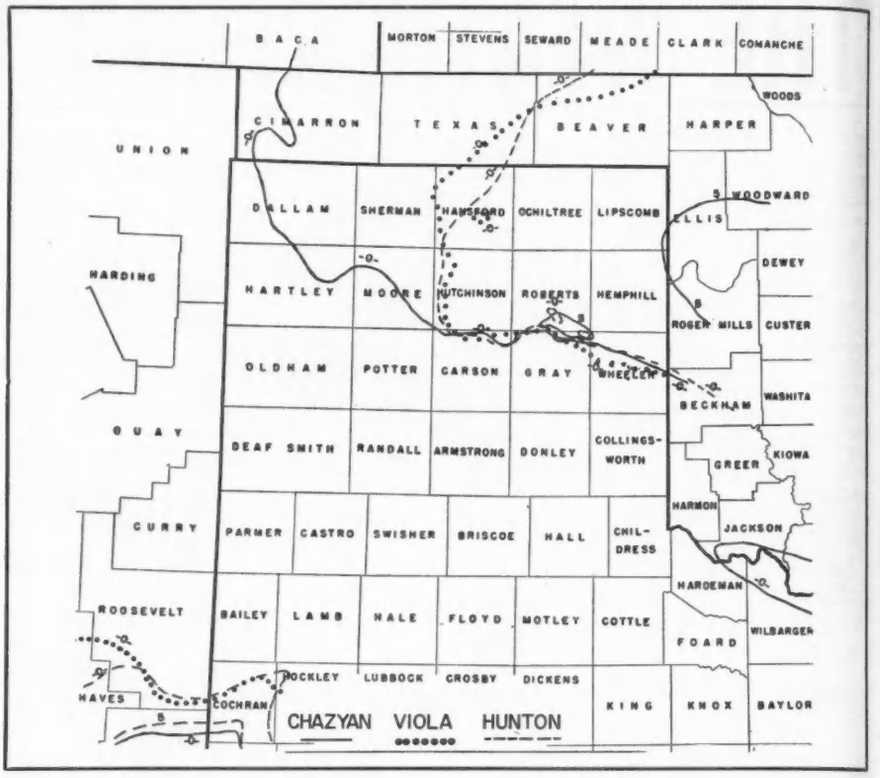

FIGURE 6—MISSISSIPPIAN. A complete sequence of Mississippian sediments is present in the area.

Sediments representing Kinderhook time consist of a basal sandstone containing some glauconite and phosphatic nodules. It is the time equivalent of the Sylamore sandstone of Oklahoma. Overlying this sandstone there is a zone of dark-gray shale and granular gray dolomite with some marl and cherty limestone. The interval is usually highly radioactive.

No production.

OSAGE—Sediments representing Osage time consist of coarsely crystalline, very fossiliferous, light-gray to white, crinoidal limestone. Milky chert is locally abundant.

No production.

MERAMEC—Sediments representing Meramec time consist of oolitic, very light gray limestone, and some dolomite. In the northwestern portion of the Panhandle, the limestone becomes dolomitic but still retains vestiges of oolites. Since the section is cherty and the cherts are sometimes oolitic, it is not always easy to separate a dolomitized Meramec section from Ozarkian rocks.

Some production in Roberts and Ochiltree counties.

CHESTER—Sediments representing Chester time consists of oolitic light-gray limestones and some soft fossiliferous gray-black shale. A basal sandstone which appears to be the time equivalent of the Aux Vases of the Mississippi Valley section is widespread. Very little chert occurs in the Chester. Due to the similarity of the oolitic limestones of the Chester and Meramec, it is difficult to make a separation where the Aux Vases section is absent between them.

The four major subdivisions of the Mississippian occur both north and south of the Amarillo axis. As there are no detrital sediments from older beds, local orogenies are not indicated except in the northwest where the basal sandstone of the Kinderhook is a quartz conglomerate. Mississippian seas covered the entire area. Age identification is based upon comparative lithologic characteristics and paleontology.

Production in Hansford County.

Part 2 will appear in the March issue of WORLD OIL

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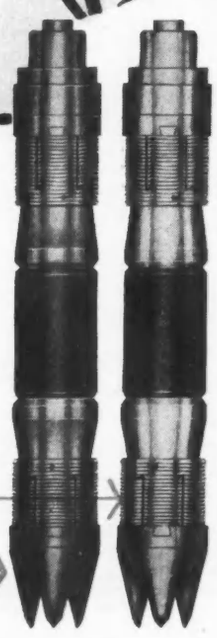
because they'll *hold*, as long as you want 'em to. The cast iron plug will outlast casing in permanent installations.

because they drill out fast. The magnesium plug in 1 to 3 hours, the cast iron type in 4 to 6 hours.

because they run in fast, on wireline, to save you time.



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Fishing Tools and Techniques
Part 1—Jars

A description of the evolution of modern fishing tools, how they operate, their advantages and limitations—starting with the jars.

By WELDON L. MEDDERS
Chief Engineer
HOMCO
Houston

THE OIL INDUSTRY is rapidly maturing into a technological giant. Today the drilling rate is over nine times faster than in 1925 (Figure 1). Pipe lines are monitored by television and mud propelled vibratory drills are penetrating granite at the rate of 30 feet per hour in the laboratory. All indicate the progress achieved in a few short years.

In the struggle to decrease drilling time the science of fishing and recovery of junk from a well has made some significant progress. Operators, engineers, and research men have worked constantly to improve on yesterday's equipment, to speed up processes, to reduce spoilage, to improve tools and equipment, to reduce the number of mis-runs, and to combine two or more operations into one. In short, the theory is that it is unwise to "compete today using yesterday's methods if you expect to be in business tomorrow."

Prior to World War II, recovery methods were more or less confined to purely mechanical tools, such as inside and outside cutters. For more than a decade these tools were subjected to constant refinement until they reached a high peak of efficiency. Run in conjunction with spears,

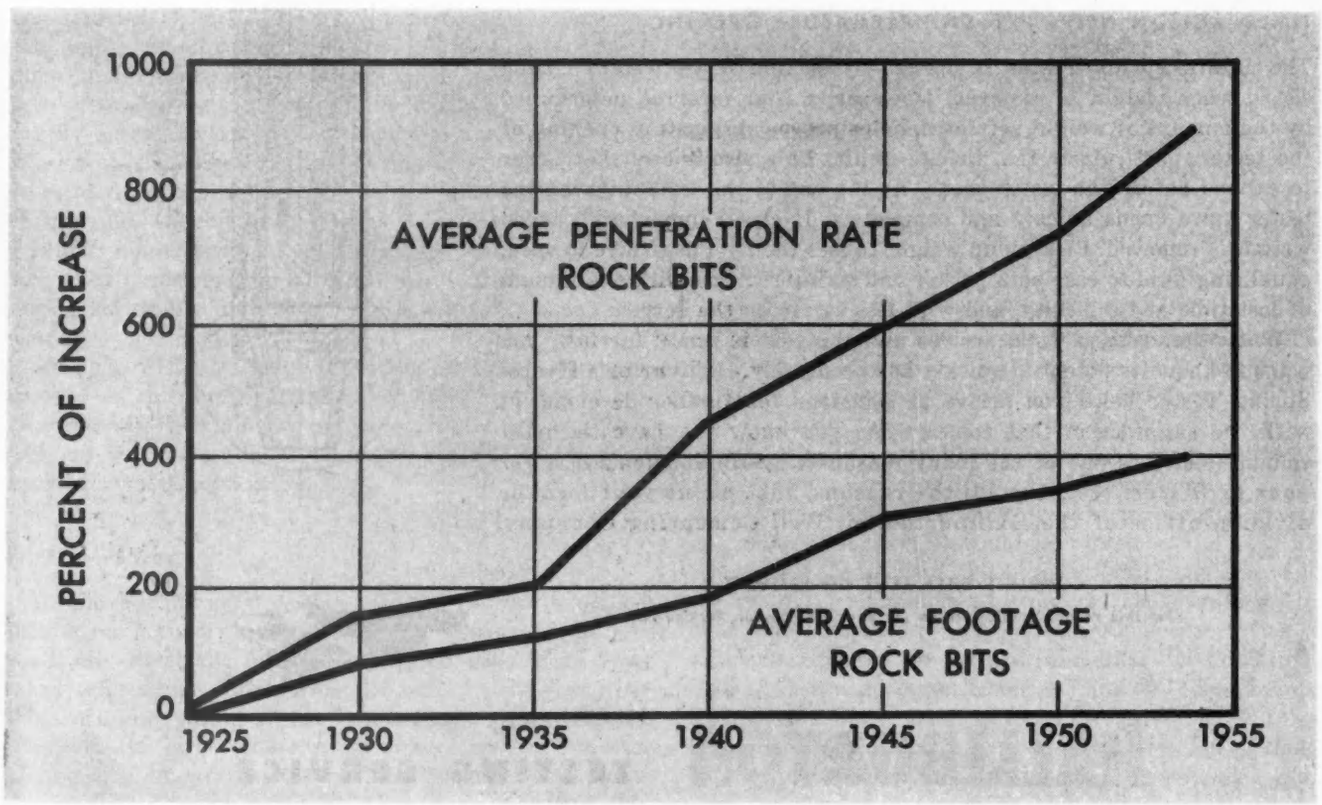

FIGURE 1—Chart showing the percentage increase in penetration rates and footages per bit. Note the steady increase in all but the early thirties.

SAVES DOWN TIME WITH RELIABLE RESULTS!

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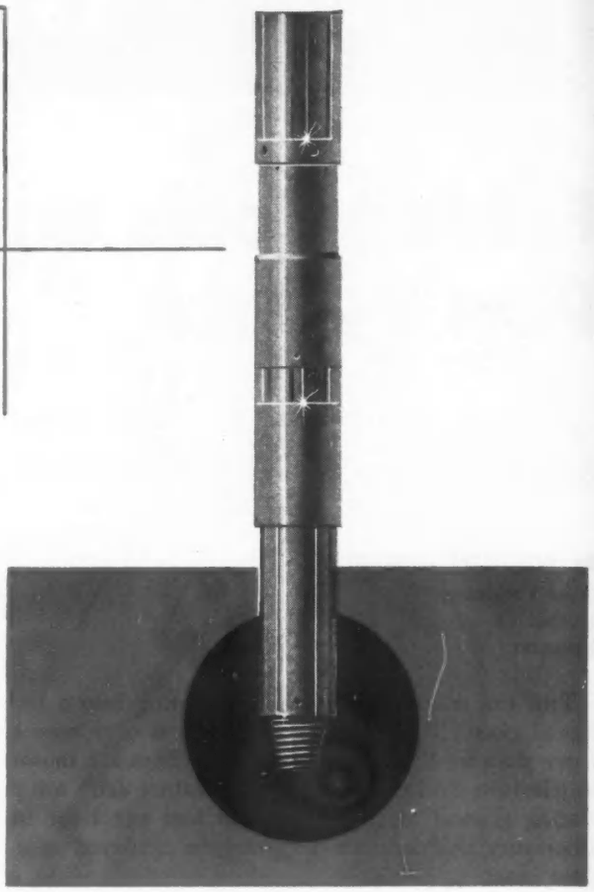
HYDRO-SPRING TESTER

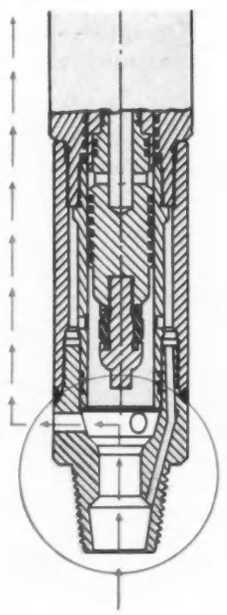


A reliable test is of vital importance, affecting decisions as to further development and completion. That's the kind you get... quickly and easily... with Halliburton's HYDRO-SPRING TESTER.

The locked-open By-Pass allows tools to be lowered with speed and ease and helps to eliminate damage to formation and packer. This important feature is especially helpful in getting the packer on bottom with a minimum of packer drag or drill pipe spudding.

AIDS AGAINST FORMATION BREAKDOWN

The By-Pass aids the packer in squeezing through tight spots caused by filter cake and thus reduces pressure build-up below the packer. It also helps prevent the forcing of mud into the formation being tested. Pressure is equalized above and below the packer until the Hydro-Spring Tester opens.



TIMED ACTION HELPS PREVENT PREMATURE OPENING

The Hydro-Spring Tester is opened by setting down weight... and closed when weight is removed. However, a *time interval,* determined by the amount of weight set down, helps prevent premature opening of the tester, particularly if a bridge is hit. This also allows the packer to expand before the tester opens. At the end of the time interval, the tester valve opens quickly and completely. It closes immediately when weight is removed. Picking up weight causes the By-Pass Valve to open, equalizing fluid to ease both packer and string removal with a minimum of lost time and difficulty, and with less strain on the derrick.

When that critical time arrives and the well is ready for test, you want to know its potential quickly and accurately. Halliburton's Hydro-Spring Tester helps you arrive at decisions for further development with the satisfaction that comes when you know you have the most reliable test. It's one of the many reasons why Halliburton's *best for your drill stem test.* For all the reasons, just phone your local or division office of the Halliburton Oil Well Cementing Company.

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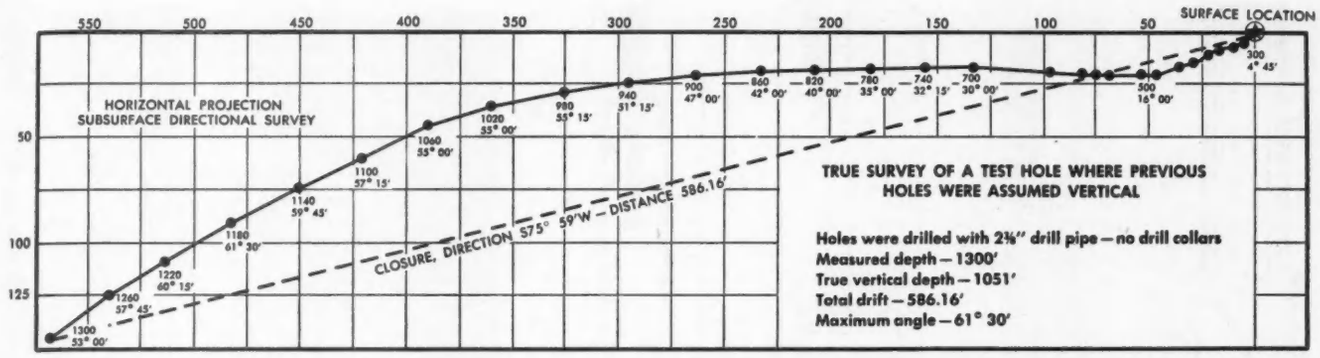
SURFACE LOCATION
HORIZONTAL PROJECTION
SUBSURFACE DIRECTIONAL SURVEY
TRUE SURVEY OF A TEST HOLE WHERE PREVIOUS HOLES WERE ASSUMED VERTICAL
Holes were drilled with 2¾" drill pipe — no drill collars
Measured depth — 1300'
True vertical depth — 1051'
Total drift — 586.16'
Maximum angle — 61° 30'
CLOSURE, DIRECTION S75° 59'W — DISTANCE 586.16'

FIGURE 2—Plot of a deviation survey of a well bore. This will give some indication of the problems encountered when trying to manipulate tools thousands of feet below the earth's surface.

overshots and bumper jars, these tools adequately fulfilled the requirements of the industry. However, following World War II, with the technological advancements incident to that period, a dissatisfaction with the old methods developed. Every phase of the industry was subject to this upheaval and technological advances with electronic computers and automation paced this progress.

The fishing tool industry certainly felt this impact. In rapid succession were seen the advent of string shooting, electronic instruments for determining the stuck point of pipe, oil jars, nitrogen jars, hydraulic pulling tools, magnetic junk baskets, and many others.

These refinements have simplified the problem of probing about in the earth for lost tools and stuck drill pipe. However, the greater portion of the credit must be given to those who have, through years of experience, mastered the fishing and recovery techniques. A drilling operation in which the drill stem is 10,000 feet long is unlike any other operation in the world. Figure 2, a survey of an actual well, shows that a straight hole, as this was supposed to be, is not always the shortest distance between two points. Should anything go wrong in such an operation there is no way of seeing what has taken place, and even worse the source of the trouble is not always readily accessible. If the drill stem parts in open hole it is anybody's guess as to the position of the fish. It may be sanded up centrally in the hole, it may be key-seated in the side wall or again it may be lost in a cavity or washout. Under such circumstances, the fishing tool operator must occasionally rely on his own intuition. As wells are drilled deeper and deeper the problem becomes more acute.

To cope with this situation, countless tools have been devised to recover pipe and other junk from the hole. One tool obsoletes another in an endless evolution which seeks as far as possible to eliminate the human element from recovery methods.

Part I—Jars

In the beginning, probably one of the oldest known methods of recovery was by jarring or hammering on the stuck fish. Since the days of cable tools there have been many refinements. Comparing the jars of yesterday with those of today would be like comparing a rig of the gay '90s with the large offshore rigs of the present. Since in jarring, the magnitude of the blow is dependent upon the square of the velocity (all tools, both new and old, have had sufficient mass), the cable tool or bumper type jars could strike little more than a sledge hammer blow depending upon the speed to which the free pipe or cable could be accelerated while being lifted a distance of two or three feet. On a rig of the '20s, measured by today's standards, both the velocity and the results are trivial. There were two limiting factors which reduced these tools to impotence; the design of the tools themselves and the equipment on which they were run.

Figure 3 shows a cable tool jar which was conceived in 1865. Figure 4 shows a weldless type cable tool jar which appeared shortly before the turn of the century and which by the early 1920s had supplanted the less efficient welded link construction. Such tools were archetypes of the modern bumper jar (Figure 5) which is still in wide usage in today's fishing strings. Its use is limited almost wholly to aiding in the release of other fishing tools such as spears and overshots by the imparting of a downward blow.

Through research and engineering, equipment has been designed whose capacity is limited only by the materials of which they are made. For instance, by simply increasing the pressure in a nitrogen jar from 1000 to 1500 pounds per square inch the elastic limit of the material is exceeded, resulting in a rapid failure of the several parts.

Modern jarring tools may be classified as follows:

1. Torque jars (Figures 6A and 6B)
2. Mechanical or spring-loaded jars (Figure 7)
3. Hydraulic or oil jars (Figure 8)
4. Nitrogen or impact jars (Figure 9)

All of the above tools have their advantages and limitations. Each in their own way have added something to the art of recovering pipe by impact.

Torque jars appeared in the early 1920s. The original Kammerdiner jars of 1924 (Figure 6A) occupies a prominent position in the industry's hall of fame. This tool was the first jar to combine tension and torque in such a manner that energy could be stored in the pipe and then suddenly released. This tool utilized mass and velocity to produce impacts which were many times greater than had ever before been possible. As a rotary type jar, this device jarred on the upstroke only. For downstroke jarring, it was necessary to operate the tool like a bumper jar (Figure 5).

A more flexible tool appeared in the late '30s as shown in Figure 6B. This tool consists of a sleeve and a mandrel, slidably mounted, both of which may be securely interlocked with right-hand torque by means of angular

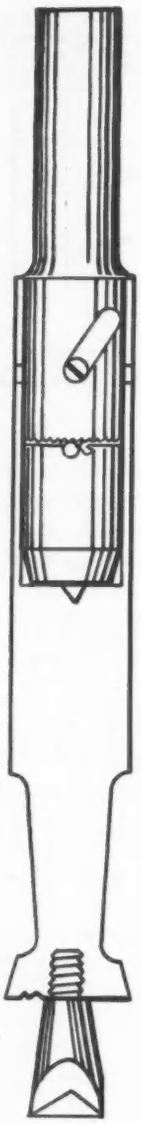

FIGURE 3—Cable tool jar of the 1800's.

FIGURE 4—Weldless cable jars that are still in use at the present time.

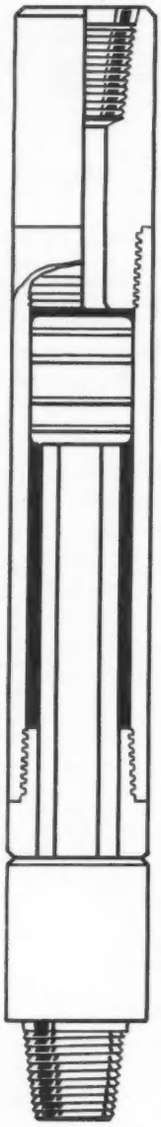

FIGURE 5—Modern bumper type jars that are used in today's rotary drilling.

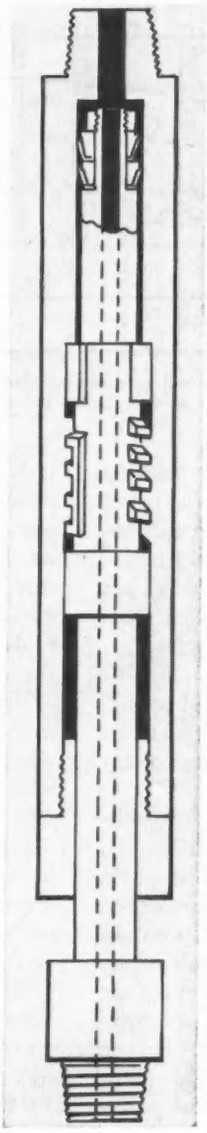

FIGURE 6a—The original Kammerdiner torque jars of 1924.

FIGURE 6b—Modern, double acting torque jars. Sleeve and mandrel are interlocked by right hand torque. An upward pull causes teeth to disengage suddenly thus imparting a considerable blow.

ratchet teeth. When sufficient upstrain is reached, the angular teeth suddenly disengage and a blow of considerable proportions results. This tool, still widely used today, may be used for downstroke as well as upstroke jarring and the magnitude of the blow may be adjusted from the rig floor.

The mechanical or spring-loaded jar (Figure 7) requires only a straight pull of the drill pipe to trip; and a straight lowering to reset. In the cocked or set position the trip spring is interlocked in relationship with the mandrel. When sufficient upstrain is taken on the drill pipe, the trip spring expands, thus releasing it from the trip mandrel. This results in a blow which may be adjusted by a disc spring assembly above the main trip spring. In this manner, considerable energy may be stored in the stretched pipe and then suddenly released, causing the anvils of the jar to strike at high velocity.

Hydraulic or Oil Jars (Figure 8): In the late 1940s the oil jar appeared. This jar also requires only straight tension for operation. The impact varies directly with the amount of strain which is taken from the rig floor. The blow is augmented by the use of one or more drill collars just above the tool. As in the case of the mechanical or spring-loaded jars, the magnitude of the blow may be increased to its optimum by adjusting the tool for greater velocity and by increasing the mass.

Nitrogen Jars (Figure 9): In considering the nitrogen or impact jars (Figure 11); it will be possible to make a comparison between the tools of yesterday and those of today. This comparison will to a great extent parallel the progress of the industry in all of its activities, whether in tools, equipment, processes or methods.

Different from its predecessors, the nitrogen impact jar concentrates its energy to moving the fish without the

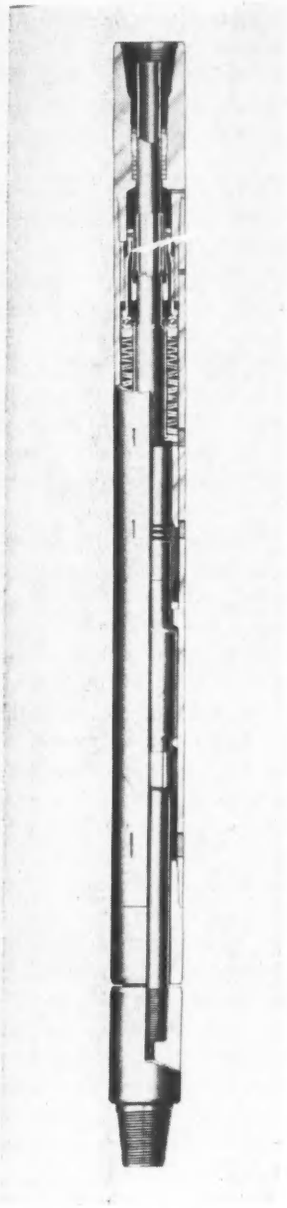

FIGURE 7—Modern oil-sealed, straight-pull jar. A straight pull will trip this jar and lowering of the drill string will reset it.

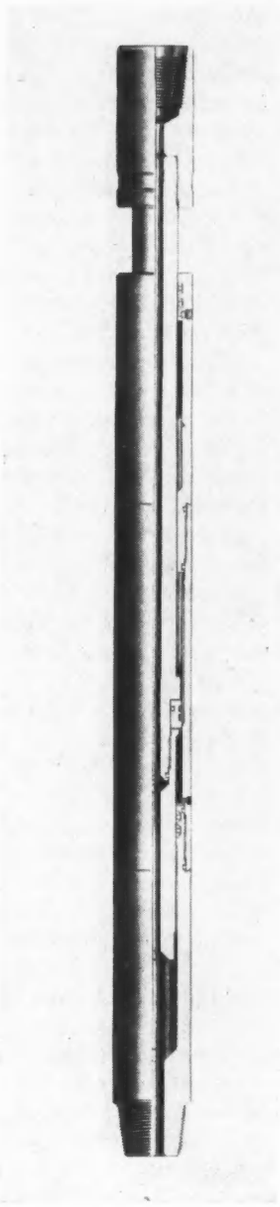

FIGURE 8—Hydraulic rotary jar in use today. This jar also only requires a straight pull to operate.

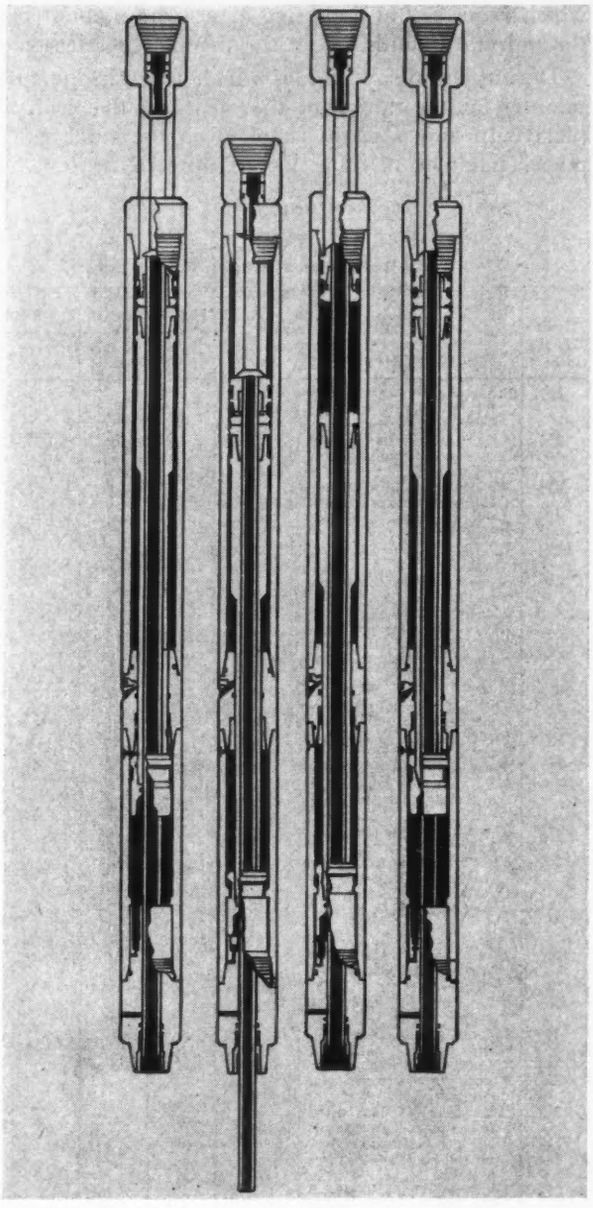

FIGURE 9—Nitrogen Impact Jars. The use of this jar eliminates most of the strain on the drill string and surface equipment. Nitrogen loaded into the tool at 1000 psi furnishes the energy to operate this tool.

characteristic jarring action on the drilling rig. There is only a very slight surface indication that the subsurface blow has been struck. Damage to surface equipment is thereby eliminated.

The jarring force is created by a free-moving hammer, driven by compressed gas, and traveling at maximum velocity striking the top of the jar. This method offers the following advantages:

1. It can be run on tubing for workover operation.

2. The energy is stored in the jar and not on the derrick floor; hence, liners and packers may be successfully jarred loose without the use of heavy surface equipment or drill pipe.

3. Drill collars are not required since the jar does not require any additional mass to augment its striking force. Greater impact can be achieved by simply increasing the initial gas pressure. By raising this pressure from 1000 psi to 1500 psi the jar itself could be destroyed.

4. A pile driver blow can be hit while the fish is under tension from the rig floor. This is analogous to taking a strain with a cat line on a set of tongs and at the same time striking them with a sledge hammer.

5. Surface equipment receives no shock whatever. To accomplish this impacting, nitrogen at 1000 psi is loaded into a chamber which contains a floating hammer.

When the drill pipe is slacked off, the gas is compressed to around 2600 psi by the floating hammer. When the drill pipe moves up, the gas expands, moving the hammer up.

Each time the hammer moves down, it gains energy due to the compression of the gas. This energy is expended each time the hammer drives upward. To utilize this source of energy for jarring, it is necessary to trap the hammer down so its upward movement will be independent of the drill pipe. This trapping or delay is accomplished by means of a piston and dash-pot design

which requires the bypassing of a given amount of fluid through an annulus before the hammer is released.

During the delay period, which is from one to three minutes, at the option of the operator, the drill pipe is picked up and a strain is taken on the stuck fish. The power hammer is being forced upward resisted by the slow passage of fluid around the delay piston. When the delay piston enters the unrestricted section it is suddenly relieved of the restricting oil fluid load and the power hammer is accelerated rapidly by the gas pressure until it strikes the top of the jar and imparts its momentum to the fish below.

TABLE 1
Field Results on Nitrogen Impact Jars

Size Jar (Inches)	FISH DESCRIPTION	No. Blows Struck	PERFORMANCE		RECOVERY	
			Successful	Unsuccessful	Successful	Unsuccessful
3½	String of cable tools w/center rope spear on bottom; 2¾ fishing neck on top	45	X	..	X	..
2⅞	4 joints 2½ inch tubing, 2 jet subs and 3 foot drill collars, 4¼ inch bit	100	X	..	X	X
4½	3 7 inch drill collars, 2 joints 4½ inch drill pipe—132 feet	(14½ hrs.)	X	..	X	..
4½	2 8 inch drill collars, 60-foot pipe and bit	5	X	..	X	..
4½	127 feet 8⅝ inch 39 pound washpipe	520	X	..	..	X
3½	3 joints 2 inch EUE tubing on top of packer	60	X	..	..	X
4½	13 6⅝ inch drill collars	3	..	X	..	X
4½	13 6⅝ inch drill collars	20	X	..	..	X
3½	3 4¾ inch drill collars w/1 joint; 3½ inch I.F. drill pipe—120 feet	20	..	X	..	X
2⅞		20	X	..	..	X
4½	2300 feet of 4½ inch X-hole drill pipe	15	X	..	X	..
2⅞	Packer 5½ inch w/30 joints 2 inch tubing free on top	8	X	..	X	..
6¼	5065 feet 4½ inch drill pipe	1	..	X	..	X
4½	2 drill collars, 1 joint 3½ inch drill pipe, and 8¾ inch rock bit	3	X	..	X	..
2⅞	96 feet 2⅞ inch tubing	40	X	..	X	..
2⅞	1 5 inch by 7 inch Packer	45	X	..	..	X
2⅞	3 feet drill collars, sub 3¾ inch O.D. and 4¾ inch rock bit	170	X	..	X	..
3½	Circulating sub 5 feet long neck 2 inch O.D.	0	3½ inch jar used w/2 inch tubing)	X	..	X
2⅞	2 inch tubing w/5½ inch 17 pound packer on bottom 1100 feet	100	X	..	X	..
3½	Setting tool for Production Packer	0	..	X	..	X
4½	60 feet 6¼ inch O.D. drill collars	3	X	..	X	..
3½	4½ inch F.H. drill pipe	12	..	X	..	X
2⅞	2 inch upset tubing and stringer out of packer	6	X	..	X	..
3½	Running w/2½ inch EUE tubing on casing swage	30	X	..	..	X
3½	3 2⅞ inch O.D. drill collars, bit and bit sub—93.52 feet overall	120	X	..	..	X
6¾	1 joint 4½ inch drill pipe, 6 6¼ inch O.D. drill collars and core barrel	100	X	..	X	..
2⅞	9 4 inch drill collars, bit sub and 5⅞ inch rock bit	3	X	..	X	..
2⅞	4 joints 2½ upset tubing, 2 jet subs, 3 foot drill collars and 4¼ inch bit	100	X	..	X	..
4½	2 7 inch drill collars, reamer and bit	1	X	..	X	..
4½	2 joint 4½ inch drill pipe, 4 7½ O.D. drill collars	100	X	..	X	..
3½	3 4¾ inch drill collars w/1 joint 3½ inch I.F. drill pipe —120 feet	..	X	..	..	X
4½	Bottom part of 4½ inch F.H. oil jars, diamond core barrel with 7⅞ inch head in a 7⅞ inch hole	25	X	..	X	..
			26	6	17	15
Totals	32 Runs		81 Percent	19 Percent	53 Percent	47 Percent

TABLE 2
Frequency of Jar Runs as Compared with Other Tools for Equal Periods of Time

TOOL	No. of Runs	Percent of Runs
Impact and Straight Pull Jars	442	40%
Magnetic and Bit Junk Baskets	194	17%
Washover Backoff Connector	256	23%
Pull Tool	222	20%
	1,114	100%

The 4½-inch size jar when screwed directly into a stuck fish will, when combined with 100,000 pounds tension from the derrick floor, impart a blow of some 258 tons or 516,000 pounds to the fish. This requires only 16¾ inches of travel at a velocity in excess of 50 feet per second.

That such extreme shock-loading, often under the most severe downhole conditions, does not induce rapid failure is indeed a tribute to the metallurgical profession; for without recent improvements in materials such a preponderance of explosive power would be out of the question.

Perhaps the staying power of modern jarring equipment under adverse conditions is best exemplified in a performance at Ault, Colo., where, after exhausting all other recovery methods, a set of 4½-inch nitrogen impact jars was called on the job. Mud in the flow line was checked at 255° F. This meant that the downhole temperature was well beyond the limit of ordinary hydraulic packing. In fact, after flowing through three steel tanks, the temperature of the return mud was still sufficiently hot to burn rubber in the suction end of the pumps. Under these conditions the nitrogen jars were moved downhole where, for fifteen consecutive days, they continued to deliver the full force of their impact. They were fired again and again in washover operations, jarring on cuts, intermingled with cleaning out hole with bit, drilling out bridges and running rough on junk. At one point in this operation, after making a cut on 8⅛-inch wash pipe, an attempt was made to jar the cut portion loose. After jarring continuously for eight hours, the 8⅛-inch N-80-39# wash pipe fatigued and snapped in two at the last scratch of a threaded joint, leaving the remainder in the hole. On another occasion a threaded pin was snapped off a 6⅝-inch drill collar.

From Table 1, tabulating field results on the nitrogen jar for a representative thirty-day period, it can be seen that this tool is about 81 percent successful as far as performance is concerned, while the percentage of successful recovery is about 53 percent.

The frequency of jar runs for recovery purposes as compared to runs by other fishing tools is given in Table 2.

Perhaps no other tool of recovery has withstood the test of time so well as the jar. It was present at the birth of the industry and it looks like it will be around in one form or another, until the last well is drilled. Each year sees its position strengthened, so that today, contrary to the position of most tools, it is actually further away from obsoletion than it was in the beginning of oil well drilling. It is a simple tool to operate and price-wise it is the most economical approach to fishing. As a quick gamble it may pay tremendous dividends, extracting with a few short blows a stuck fish that would otherwise require days or even weeks to extricate by other methods.

EDITOR'S NOTE

The second of this series of six articles will appear in the March issue of WORLD OIL and will deal with the use of interspersed carbides on fishing, cutting, and milling tools.

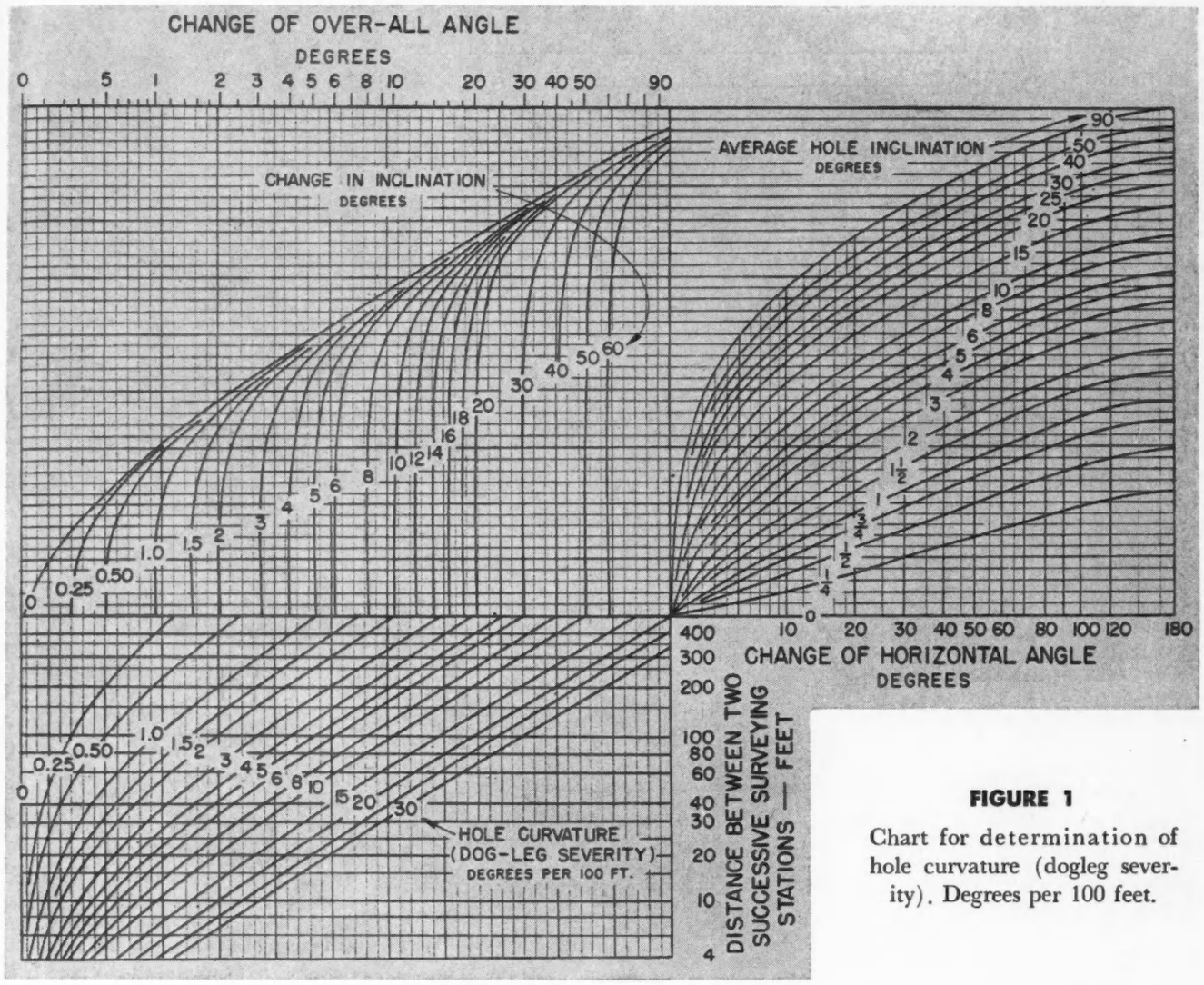

FIGURE 1

Chart for determination of hole curvature (dogleg severity). Degrees per 100 feet.

How Severe Is That Dogleg?

If a single shot directional survey indicates a change in both the inclination and direction, the severity of the dogleg can be read directly from charts.

By ARTHUR LUBINSKI
Research Department
Stanolind Oil and Gas Company
Tulsa

IN RECENT YEARS, large savings have been made in drilling "crooked" formations by not decreasing weight on bit and, whenever possible, permitting the deviation to build up to larger values than in the past. However, in presence of faults and/or unconformities, even if the deviation is permitted to build up, the weight is still frequently decreased because of a fear that the hole might drift in an undesirable direction or that a severe dogleg might result. If conventional inclinometer surveys were replaced by single-shot direction surveys, then these fears could be eliminated and more weight could be carried, thus realizing additional savings. Such surveys would permit one to know, at any time, the direction of the drift, and to detect doglegs. British-American runs such surveys in all their wells drilled in crooked hole areas in Oklahoma. They claim that the rental costs of a non-

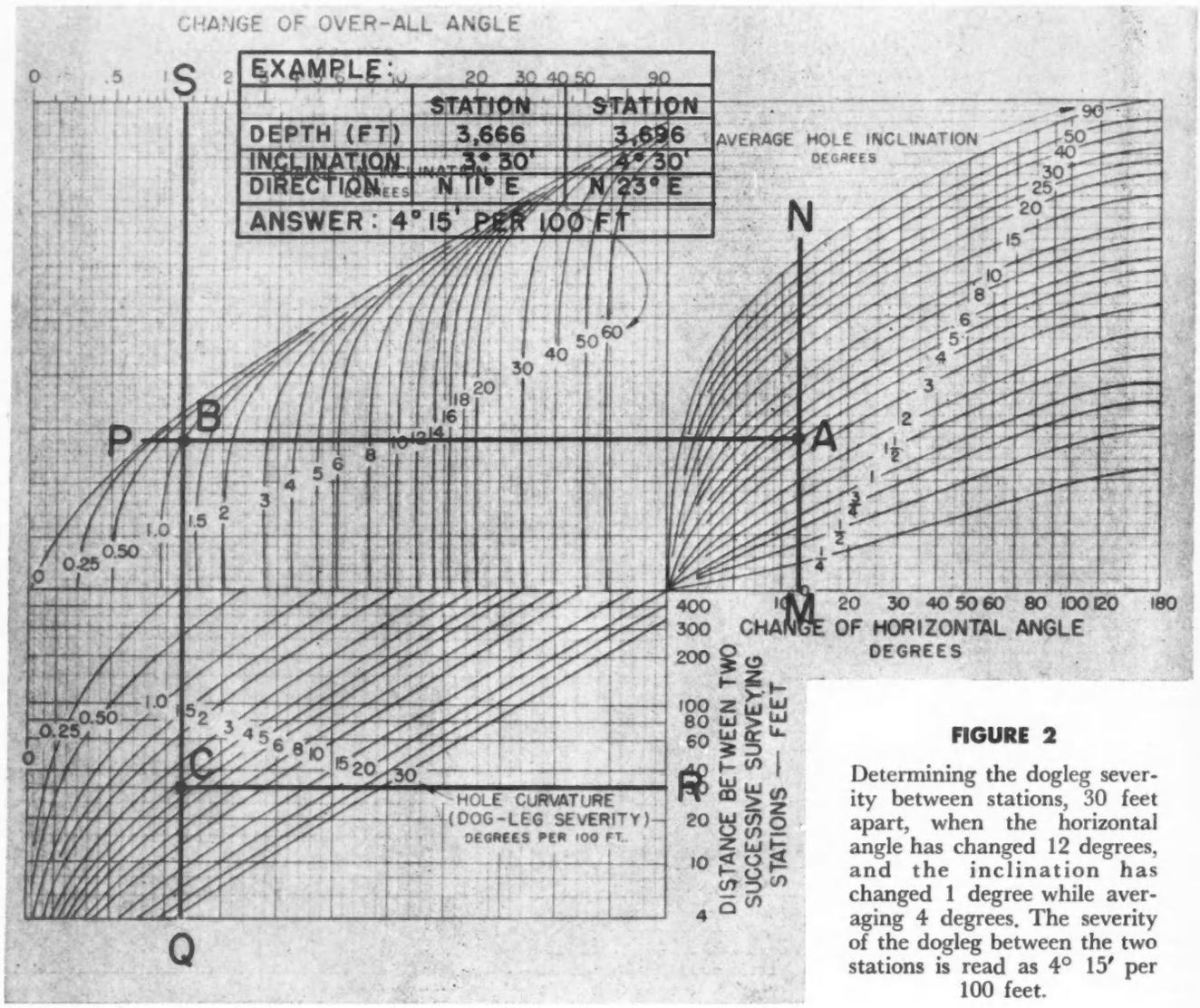

FIGURE 2

Determining the dogleg severity between stations, 30 feet apart, when the horizontal angle has changed 12 degrees, and the inclination has changed 1 degree while averaging 4 degrees. The severity of the dogleg between the two stations is read as 4° 15′ per 100 feet.

magnetic drill collar and a single-shot instrument, which are of the order of $30 per day, are largely offset by drilling savings.

A dogleg, even a severe one, does not cause immediate trouble, because the drill collars, being under compression, accommodate themselves easily to variations in the hole course. It is only much later that a dogleg may become responsible for troubles and large losses of money. When drilling a few thousand feet below the dogleg, the tool joints at the vicinity of the dogleg press against the wall of the hole with a large force. The detrimental effects of this force are as follows:

- Fast wear of tool joints.
- Key seats in the hole.
- Worn spots in the casing, which may result in its collapse early in the producing life of the well.

In addition, doglegs may cause pumping difficulties.

Therefore, early detection of doglegs is desirable. In the event one appears in the hole far above the expected total depth, and if the dogleg is very severe, then it should be reamed or the hole sidetracked. Fortunately, severe doglegs, which generally occur in formation unconformities, are rare. Although it is not known from statistical data, it may be estimated that they occur once in 50 or 100 wells drilled in "crooked" formations.

A clause of maximum dogleg severity is currently being written into British-American drilling contracts pertaining to wells in which the surface location is chosen by the contractor.[1,2] In these wells, advantage is taken of the natural drift of the hole instead of attempting to combat it.

The dogleg severity is generally expressed in degrees per 100 feet. For explanatory purposes, consider a simple case in which the direction of the drift does not change and directional data are not needed. Imagine two successive surveying stations 50 feet apart. Assume that hole inclinations are 4 and 6 degrees at the two stations. Then the average dogleg severity between these stations is equal to:

$$6° - 4° = 2°/50 \text{ feet} = 2 \times \frac{100}{50} = 4°/100 \text{ feet.}$$

In directional drilling, whipstocks are generally set in a way so as not to exceed a dogleg severity of 5 degrees/100 feet, which does not result in any trouble. Therefore, such doglegs can also be accepted in non-directional drilling. How much more severe doglegs could be tolerated depends upon the distance from the dogleg to the total depth and size of hole, drill pipe, casing, tubing, sucker rods, etc. The effect of these variables on the maximum

MEMOGRAM

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WEB WILSON OIL TOOLS, INC.

TO ALL OPERATORS AND DRILLING CONTRACTORS:

We are pleased to announce that we have under contract IKE N. SELLEM, who will function as sales consultant, roving representative and advertising adviser for our company. With an admitted worldwide reputation for selling oil tools, we are fortunate indeed to have secured his services. Inasmuch as nothing I might say could be so revealing or interesting as his own story, permit me to introduce IKE N. SELLEM.

W. A. Wilson

President WEB WILSON OIL TOOLS, INC.

WAW-M

WHO I AM, AND WHY IKE N. SELLEM

First of all I am going to let you in on a secret about my very unusual name, IKE N. SELLEM. I feel embarrassed that I haven't explained this to all my oil country friends long ago. You see, that isn't really the name Pa and Ma Sellem gave me. They christened me ICHABOD NIMROD SELLEM, a

good enough name, I guess, for any *ordinary* kid. But as I grew up and got into the selling game and started going to town, everybody saw right off that I was going to be not an *ordinary* salesman, but a *super*-salesman. So it seemed a good idea to change my name a little and give folks some warning of my outstanding ability before I started my sales pitch. That's how come IKE N. SELLEM, and I'm pleased to meet you. I hope you will all be friendly.

I never would have let that Web Wilson outfit talk me into working for them if it hadn't been that a lot of my very best friends kept tellin' me that Web Wilson made the world's best hooks and tongs and elevators, but that they sure needed a man like me to sell 'em. With a name and a reputation like mine, it seemed a natural, so here I am on their payroll, and after looking things over I'm tellin' you "there'll be some changes made."

LANDIS

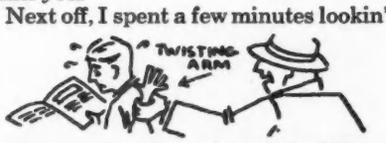
HILLIARD

GORMAN

My first job was to size up the sales managers: By Landis, VP (Vice President, that is), Ben Hilliard, and Ray Gorman—all good boys, with friends all over, and trying their best to "manage" to sell oil tools. BUT, they just didn't seem to have those two vital virtues which distinguish a *super*-sales-manager, like me, from just ordinary sales managers... Number 1, ABSOLUTE CONFIDENCE in their ability to sell ANYbody ANYthing ANYtime; and Number 2, COURAGE (some folks call it guts) to say to every oil man they call on, "Don't just sit there—buy something!"

See what I mean? I'm not knocking any of those boys, but *you* know as well as I do that a fellow has to have BRASS intestines, a STEELY eye, and a PLASTIC rear end to sell PIG IRON. So I'll have to show those men how to sales-manage; and don't say I didn't warn you.

Next off, I spent a few minutes lookin'



over the advertising that Web Wilson has been doing in the oil magazines, and it didn't take me long to spot something mighty important. They've been printing a lot of those fancy colored pictures showing yellow tongs and hooks and power slips *right on the rig*, and with *real crews* handlin' them. Mighty pretty pictures, but they should have had a master salesman like me standin' on the derrick floor tellin' you just *how* good they are, and *insisting* that you buy 'em.

You know and I know that if IKE N. SELLEM (in person) had been there when you were lookin' at those pretty colored pictures, talkin' low and convincin' and twisting your left arm a little, you would have signed an order—at least before any bones broke. So, from here on in I'll be right alongside when you're lookin' at any Web Wilson "ads"—explainin' and suggestin' and putting on a leetle pressure. And I don't want you to miss *any* ads—look 'em up in the index to be sure—and let's get together often.

Yes sir, President Wilson was real lucky when he signed me up because I can be a lot of help sellin' his yellow iron, and he was smart enough to see it right away. When I told him I would introduce his men such as Johnny Deaver in Louisiana; Merrick Phelps in Houston; and "Export Bob" Eiche to

DEAVER

PHELPS

EICHE

some of my old buddies who are BIG wheels, El Presidente Wilson seemed real pleased. And, when I promised that I'd show Bob Cooper in the Rockies, and George Badger in Canada, and Big Ed Plaugher in California how to "get in and get out with an order"—well he really drooled.

COOPER

BADGER

PLAUGHER

It's going to be wonderful to have a chance to talk to all my friends month by month in these oil magazines—and get paid for doin' it—so look me up in each issue. And I'll judge from your orders for Web Wilson Tools whether you are following my suggestions.

I'll get around to see all of you in person just as fast as I can, and give *you* a chance to talk. But it's a mighty big oil patch, so look for me in your favorite oil magazine in the meantime.

Please direct those orders to me *personally* and I'll see they get the very best attention. And that will also prove to the boss man that...

Ike N. Sellem

P.S. If any of my fans would like my photograph, complete with autograph, just write me and ask for it. Being a big shot, I operate out of the Home Office, so my mailing address is P.O. Box 72096, Los Angeles 2, California.

(Advertisement)

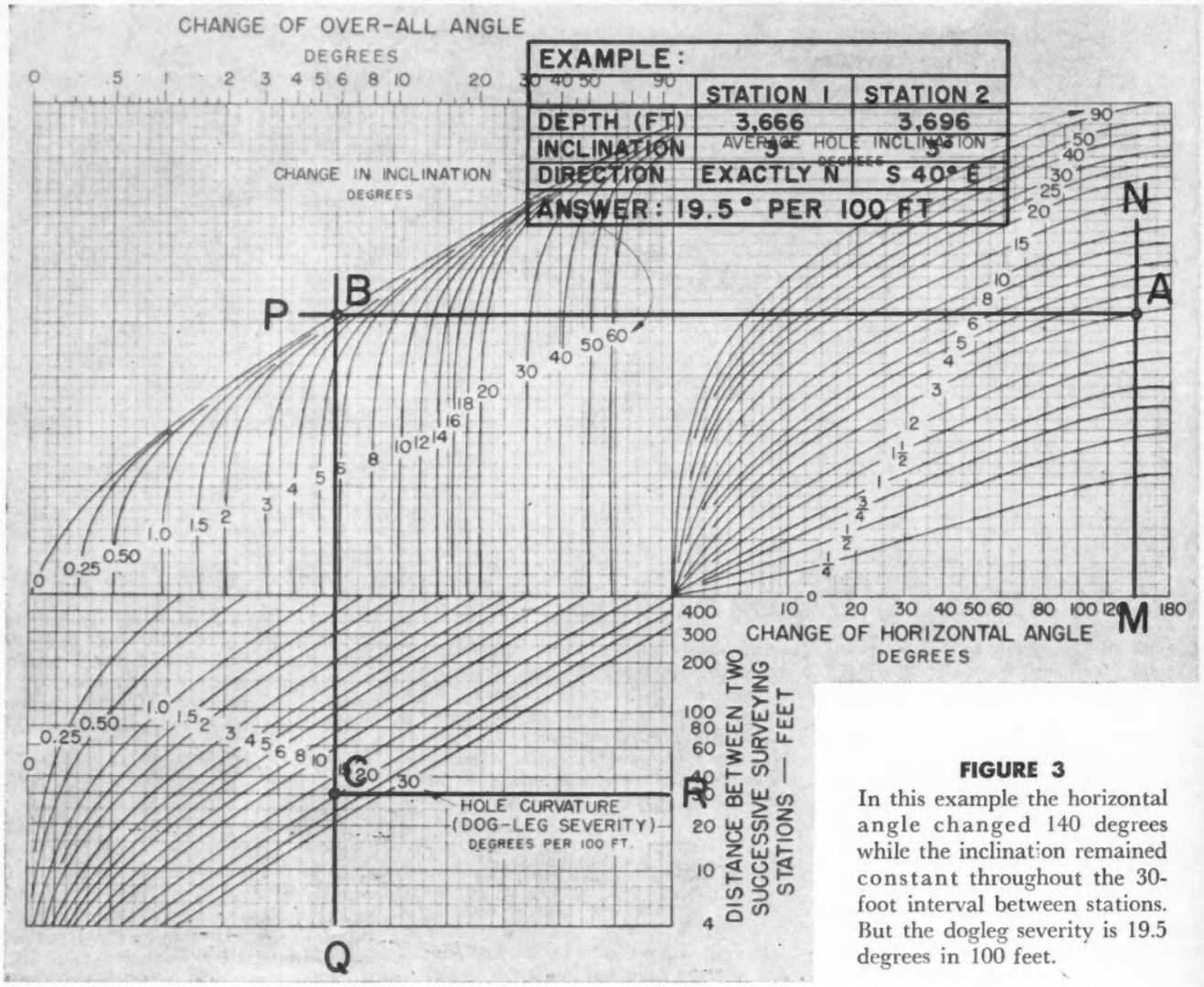


FIGURE 3
In this example the horizontal angle changed 140 degrees while the inclination remained constant throughout the 30-foot interval between stations. But the dogleg severity is 19.5 degrees in 100 feet.

tolerable severity of doglegs will be better known after more theoretical work is done and more field data are gathered.

Several means are available for determining the average severity of a dogleg in the general case when the dogleg is due to a change in both the inclination and the direction. One oil well survey company uses a graphical method which requires use of either a protractor and a compass or an apparatus incorporating these two and called "Ouija Board."[3,4] Stanolind Research department developed means consisting of the use of trigonometric formulae.

British-American uses a method[5] in which the results are not given in degrees per 100 feet as is normally the case.

In this paper a new chart is presented which permits one to read the dogleg severity directly.

The problem of determining dogleg severity was discussed on July 31, 1956, at a meeting of the Crooked Hole Subcommittee of the AAODC Rotary Drilling Committee, held in Midland, Texas. The desirability of standardizing the terminology was stressed. In the past, the dogleg severity has also been designated as follows: rate of change of the over-all angle (Stanolind; horizontal departure (British-American); and hole curvature. The committee recommended the following designation: "Hole curvature (dogleg severity)." This first expression is destined to be used in drilling contracts and the parenthetical expression is temporarily added to assure a fuller understanding of field personnel.

Procedure for Preparing the Chart

The formula of hole curvature is derived in the Appendix, by use of solid geometry and trigonometry. Means by which this formula was used in preparing the chart is also given in the Appendix.

Discussion and Results

With Figure 1, the average value of hole curvature (dogleg severity) between two successive directional survey stations may be directly obtained. The use of the chart will be explained with the following numerical example:

	Station 1	Station 2
Depth (feet)	3666	3696
Inclination with respect to vertical	3° 30′	4° 30′
Direction of the inclination	N 11° E	N 23° E

The following calculations must first be made:
(1) Change of horizontal angle $23° - 11° = 12°$
(2) Average hole inclination $\frac{1}{2}(3\frac{1}{2}° + 4\frac{1}{2}°) = 4°$
(3) Change in inclination $4\frac{1}{2}° - 3\frac{1}{2}° = 1°$
(4) Distance between the two successive surveying stations 3696 feet — 3666 feet = 30 feet.

CAT* D397s ..."FAST ON THE DRAW"

Powering a Turney draw works for Clegg & Hunt Drilling Co., of Houston, Texas, these three Caterpillar D397 Engines really proved themselves in their first six months of work. The rig is shown drilling on a site five miles south of Lake Arthur, La. The amount of hole made varies up to 2000 feet in 24 hours. And the engines are operating day and night, seven days a week.

Equipped with torque converters and compounded to power both draw works and mud pump, the D397s are giving outstanding performance. L. L. Bond, tool pusher, says the D397s have not only given excellent service but show a real advantage on the draw works because of their fast acceleration. "They respond much quicker than other diesels," he reports.

Ask any owner of Cat Oilfield Engines what he likes most about them. He'll tell you their *dependability* makes them a profitable investment. It's a fact that there are Caterpillar Diesels still powering rigs after more than 100,000 hours of heavy-duty work. They're quality-built to stay on the job for years.

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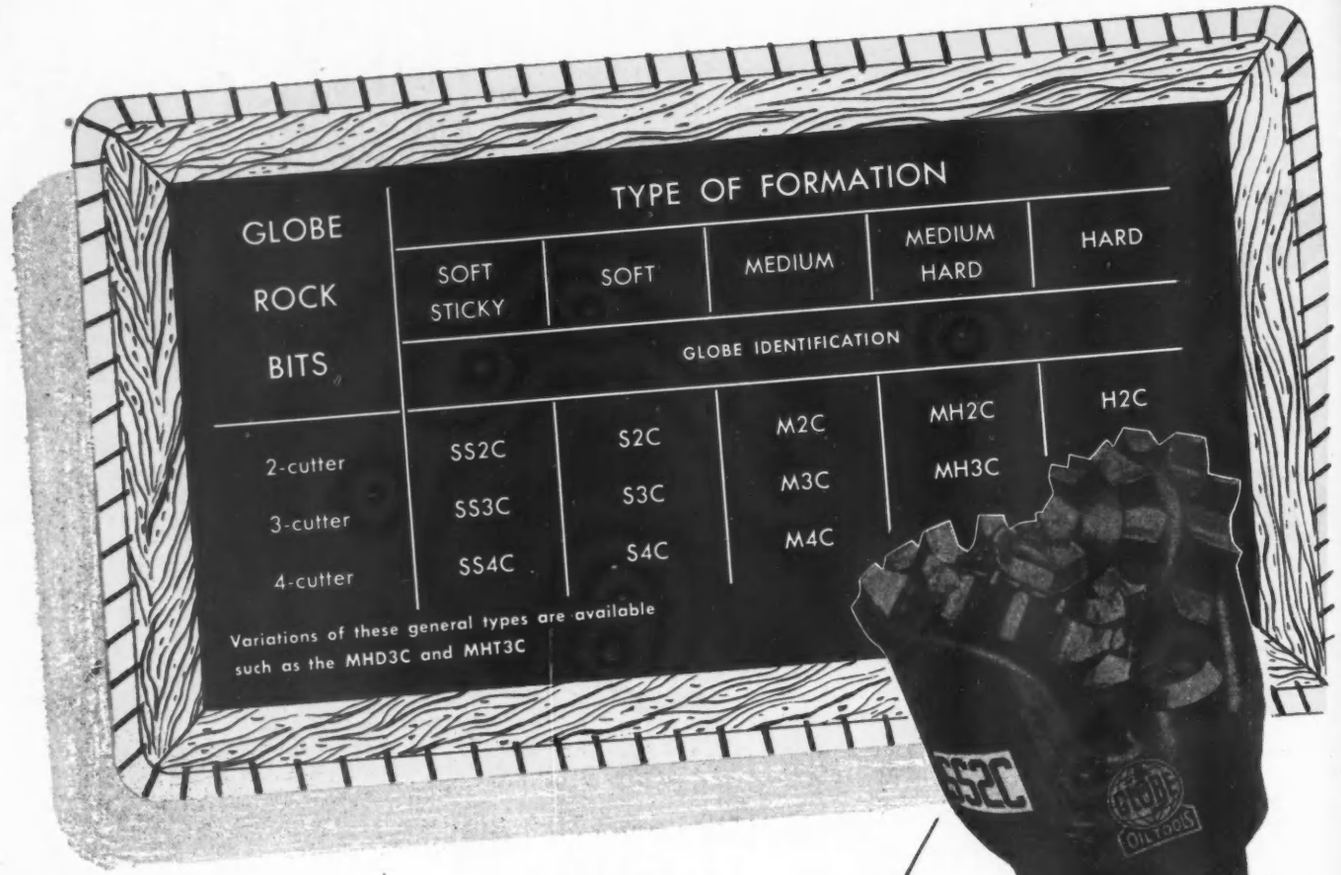

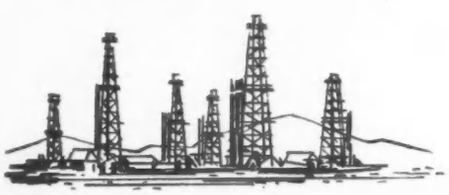

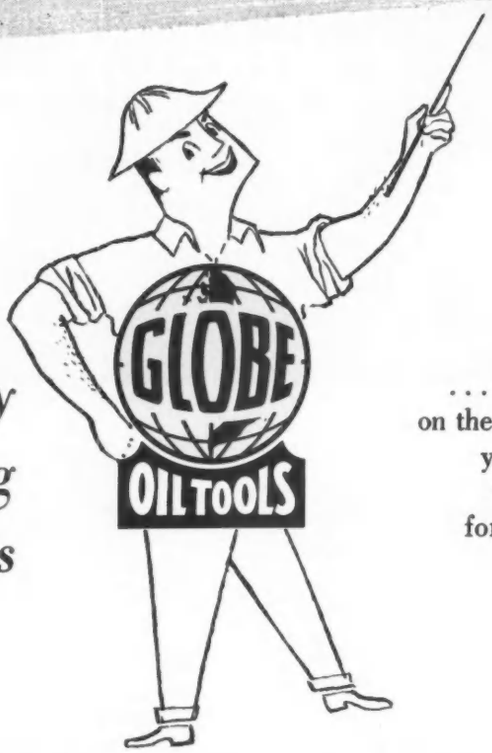

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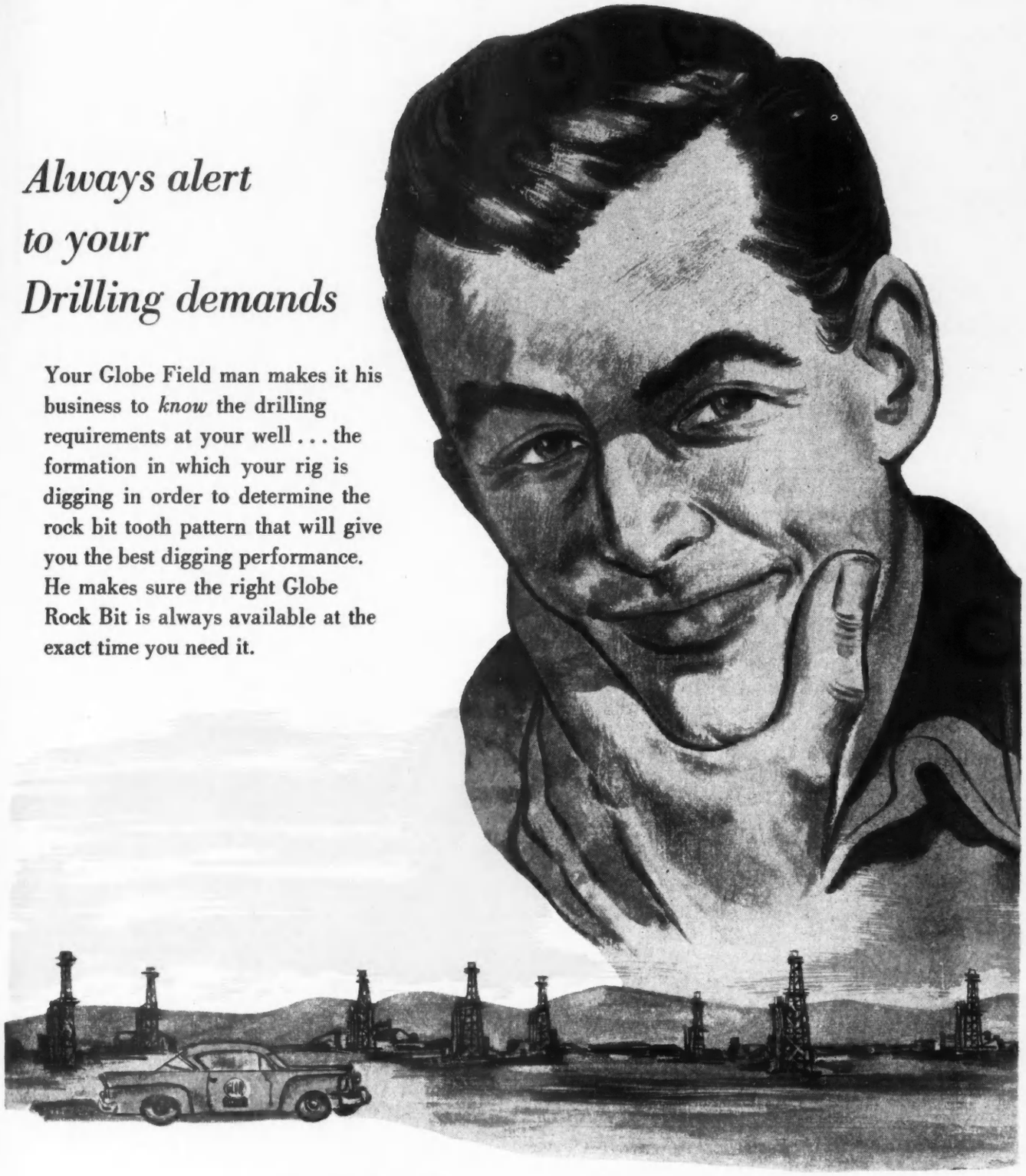

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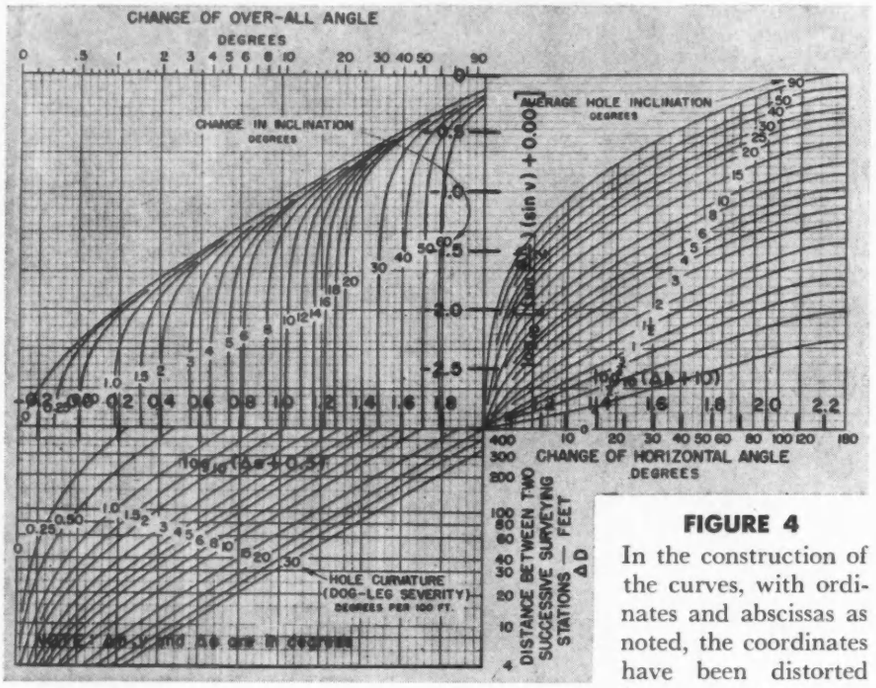


FIGURE 4

In the construction of the curves, with ordinates and abscissas as noted, the coordinates have been distorted for more suitable distribution of the curves.

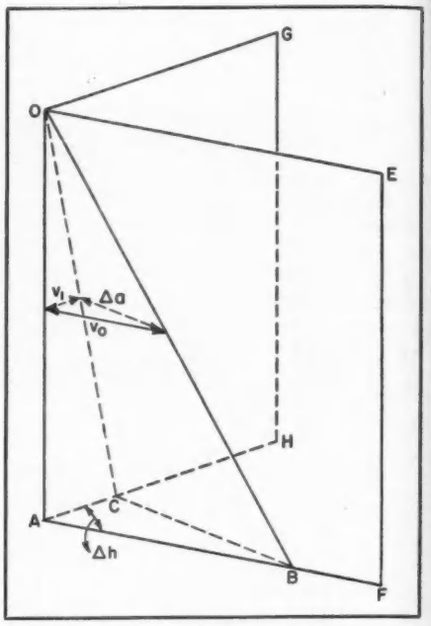


FIGURE 5

Graphical representation of inclination of well bore from the vertical and change in direction of the inclination.

How the hole curvature (dogleg severity) is determined with the chart is shown in Figure 2.

Since the change of horizontal angle is 12°, construct the vertical line MN. Find its intersection with the 4° curve at A (4° is the average hole inclination). Proceed along the horizontal line AP until its intersection with the 1° curve at B (1° is the change in inclination). Construct the vertical line BQ. The horizontal line from R (30 feet is the distance between stations) intersects BQ at C, which indicates the following answer:

Average hole curvature (dogleg severity) between the two surveying stations = 4° 15′ per 100 feet.

In the above case, the rate of change of the hole inclination is 1° per 30 feet, i.e., 3.3° per 100 feet. Therefore, the contribution of the change of the horizontal angle, although not negligible, is not predominant. The following example illustrates a situation in which the change of horizontal angles does predominate.

	Station 1	Station 2
Depth (feet)	3666	3696
Inclination with respect to vertical	3°	3°
Direction of the inclination	Exactly N	S 40° E

Then (1) Change of horizontal angle = 140°
(2) Average hole inclination = 3°
(3) Change in inclination = 0°
(4) Distance between the two successive surveying stations = 30 feet.

In a similar manner, as for Figure 2, the average hole curvature (dogleg severity) between the two surveying stations under consideration, as obtained from Figure 3, is equal to 19.5° per 100 feet.

There is a scale on the chart which, being of less significance, has not been explained so far, namely, the scale of the change of over-all angle rather than hole curvature, which is the rate of change of this angle. In the case of Figure 2, the change of over-all angle is read at S and is equal to 1.3°. This value may also be obtained from the previously determined value of hole curvature in the following way:

4.5° per 100 feet is approximately equal to 1.3° per 30 feet.

APPENDIX

Derivation of Formulae

Figure 5 represents two vertical planes OAFE and OAHG intersecting along the vertical line OA. Consider that at a certain depth the tangent to the axis of the hole is parallel to the plane OAFE and that the angle AOB, designated as v_0, is equal to the inclination of the hole. Consider that somewhat deeper in the hole the axis of the hole became parallel to the plane OAHG and that the angle AOC, designated as v_1, is equal to the new inclination of the hole. The change of horizontal angle is represented by the angle FAH, designated as Δh. The over-all change of angle is, of course, equal to the angle BOC and is designated as Δa.

The following relationships are obvious when considering the right triangles OAB and OAC respectively:

$$AB = OA \tan v_0 \quad (1)$$

$$AC = OA \tan v_1 \quad (2)$$

In the triangle ABC we have:

$$\overline{BC}^2 = \overline{AB}^2 + \overline{AC}^2 - 2\,\overline{AB}\,\overline{AC}\cos(\Delta h) \quad (3)$$

Substituting (1) and (2) into (3), we obtain:

$$\overline{BC}^2 = \overline{OA}^2\,[\tan^2 v_0 + \tan^2 v_1 - 2 \tan v_0 \tan v_1 \cos(\Delta h)] \quad (4)$$

In the right triangles OAB and OAC we have, respectively:

$$OB = \frac{OA}{\cos v_0} \quad (5)$$

$$OC = \frac{OA}{\cos v_1} \quad (6)$$

In the triangle OBC we have:

$$\overline{BC}^2 = \overline{OB}^2 + \overline{OC}^2 - 2\,OB\,OC\cos(\Delta a) \quad (7)$$

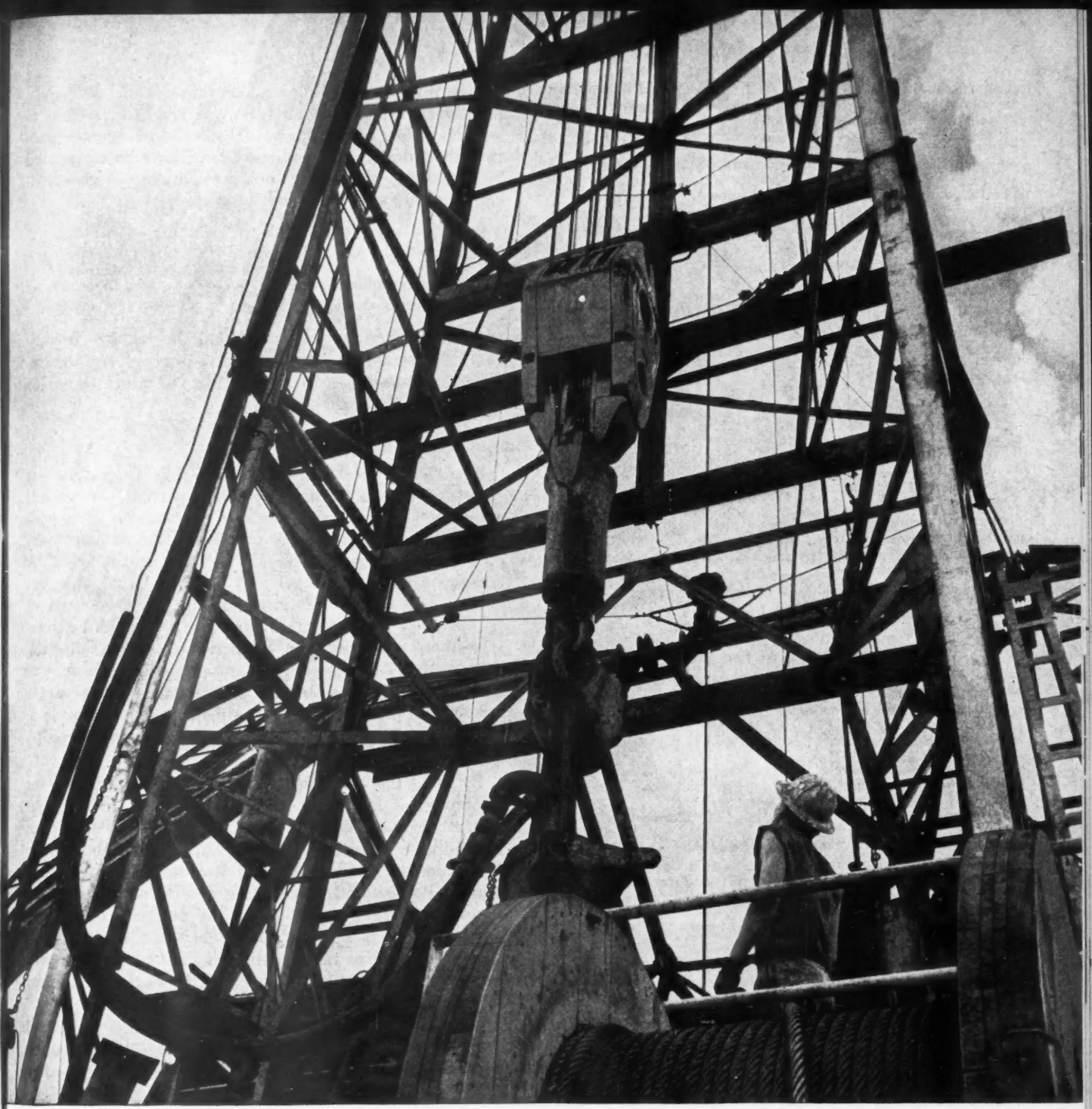
Substituting (4), (5), and (6) into (7) and solving for cos (Δa), we obtain:

$$\cos(\Delta a) = \frac{\dfrac{1}{\cos^2 v_0}\,\dfrac{1}{\cos^2 v_1} - \tan^2 v_0 - \tan^2 v_1 + 2 \tan v_0 \tan v_1 \cos(\Delta h)}{\dfrac{2}{\cos v_0 \cos v_1}}$$

which may be transformed as follows:

$$\cos(\Delta a) = \cos v_0 \cos v_1 + \sin v_0 \sin v_1 \cos(\Delta h) \quad (8)$$

Formula (8) would be convenient only if Δa were large. For



WIRE ROPE AT WORK

Northeast of Tioga, North Dakota, standing like a tall sentinel on the open prairie, this rig had drilled to 5300 ft when our photographer stopped by. It was at work on the Nelson Well No. 1, and the hole at that time was making good progress through crumbly shale and sand.

The neat, well-kept outfit is the property of Paul F. Rutledge Drilling Co., Santa Fe, N. M. For the rotary line, the owner consistently specifies 1⅛-in. Bethlehem Purple Strand, 6 x 21 Seale. The line shown here had 20,000 ton-miles to its credit, after approximately nine months on the rig. It was obviously "right" for the job it was doing; showed little evidence of wear, and looked fit for a long and useful life.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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relatively small value of Δa, $\cos \Delta a$ is almost equal to unity and Δa cannot be calculated with tables. For this reason, Formula (8) has been transformed as follows:

$$\cos(\Delta a) = \cos(v_1 - v_0) - \sin v_0 \sin v_1 [1 - \cos(\Delta h)] \quad (9)$$

$v_1 - v_0$ is the increase of inclination and will be designated as Δv

$$v_1 - v_0 = \Delta v \quad (10)$$

The following relationships are well known:

$$\cos(\Delta a) = 1 - 2\sin^2\frac{\Delta a}{2} \quad (11)$$

$$\cos(\Delta v) = 1 - 2\sin^2\frac{\Delta v}{2} \quad (12)$$

$$1 - \cos(\Delta h) = 2\sin^2\frac{\Delta h}{2} \quad (13)$$

Substituting (10), (11), (12), and (13) into (9) and solving for $\sin^2\frac{\Delta a}{2}$, we obtain:

$$\sin^2\frac{\Delta a}{2} = \sin^2\frac{\Delta v}{2} + \sin^2\frac{\Delta h}{2}\sin v_0 \sin v_1 \quad (14)$$

from which

$$\Delta a = 2 \arcsin\sqrt{\left(\sin\frac{\Delta v}{2}\right)^2 + \left(\sin^2\frac{\Delta h}{2}(\sin v_0)(\sin v_1\right)} \quad (15)$$

Generally, the hole inclinations v_0 and v_1 at two successive surveying stations are close to each other. Therefore, these inclinations may each be replaced by the average value v; thus, Equation (15) becomes:

$$\Delta a = 2 \arcsin\sqrt{\left(\sin\frac{\Delta v}{2}\right)^2 + \left(\sin\frac{\Delta h}{2}\right)^2 (\sin v)^2} \quad (16)$$

Construction of the Chart

The previously explained chart is a graphical representation of Equation (16).

The abscissa and the ordinate of the upper right section are essentially Δh and $\left(\sin\frac{\Delta h}{2}\right)(\sin v)$ respectively. Several curves, each for a constant value of v, have been computed and plotted.

Also, the abscissa and the ordinate of the upper left section are essentially Δa and $\left(\sin\frac{\Delta h}{2}\right)(\sin v)$. Curves for constant values of Δv have been computed and plotted.

The abscissa and ordinate of the lower left section are essentially Δa and ΔD (distance between two successive surveying stations). Curves for constant values of $\Delta a/\Delta D$ have been computed and plotted.

The word "essentially," used several times in the above paragraphs, means that coordinates have been distorted as indicated in Figure 4 to get a more suitable distribution of curves.

Editor's Note: Comments, recommendations and conclusions included in the discussion following presentation of the paper are noted:

It was unanimously agreed that the paper provides the industry with a convenient chart for determining hole curvature. It was recognized that the only disadvantage of running single-shot directional surveys is the cost. On the other hand the probable advantages are:

a. More weight on the bit since the danger of drilling outside the lease limits is minimized.
b. Decrease possibility of, or even elimination of key seat or stuck drill pipe.
c. Less tool joint and drill pipe wear.
d. Less casing collapse.
e. Appreciable reduction in producing costs by reducing beam pumping difficulties due to hole curvature.

In a discussion of the chart itself it was pointed out that, for sake of simplicity, the construction of the chart is based upon an approximation which gives values of hole curvature that are somewhat too large. The error due to use of the chart is, however, negligible if the ratio of hole inclination in two successive survey stations is no greater than two. In almost all actual cases this ratio is, in fact, smaller than two except when the hole is close to vertical at one of the stations. If the ratio is greater than two, then the above mentioned error may be eliminated by considering the average hole inclination as a geometrical rather than an arithmetical mean.

Example:

Station 1	Inclination = 0° 30′	= ½ degree
Station 2	Inclination = 4° 0′	= 4 degrees
Arithmetical mean = ½ (½ + 4)		= 2.25 degrees
Geometrical mean = $\sqrt{(½)(4)} = \sqrt{2}$		= 1.41 degrees

Finally, it was recommended that the industry investigate the merits of this method pioneered by British-American and that a maximum hole curvature clause be written into drilling contracts.

DISCUSSION

The "Chart for Determination of Hole Curvature" by Lubinski presents a simple method of placing a numerical value on hole curvature, so that for a given area with some experience it should be possible to eliminate ordinary drift readings and utilize curvature measurements. A comparison of Examples 1 and 3 in the paper indicates the fallacies of drift readings on which a large part of the industry now depends. Example 1 would be considered by many to be a hazardous situation since the drift increases from 4 degrees to 6 degrees in 50 feet of hole. Since the direction did not change, the curvature is 4 degrees per 100 feet. By comparison with Example 3, the drift had not changed, which would be considered by many to be a good hole.

By using the chart, it is noted that the curvature for Example 3 is 19.5 degrees per 100 feet, which compares with 4 degrees per 100 feet in Example 1. This is not surprising to those who have studied the problem closely. Utilization of the chart makes it very simple to determine curvature and by comparison with drift, the chart should be helpful in amplifying the difficulty of using a drift reading alone. The chart gives the same values, without the use of mathematics, as calculated by Wesley Moore of The British-American Oil Producing Company in the method previously presented by Moore.

This straight hole committee, four years ago, presented a "Need for Definition of a Crooked Hole." That paper was prepared to provoke thinking while the complete problem was studied. With this chart and some experience, a crooked hole may soon be defined. To make this definition a reality, this committee should review directional surveys, determine the curvature from Lubinski's charts, correlate with drilling or producing problems, and for certain areas determine the maximum values that can be tolerated without difficulty.

REFERENCES

[1] "Unique Contract Plays Part in Oklahoma's Deepest Well," by Claude Barrow; *Drilling*, March, 1956.

[2] "Two Contract Features That Promote More Economical Drilling," by Fred Norris; paper presented at API Division of Production Meeting, Wichita, Kansas, April, 1956.

[3] "The Eastman Removable Whipstock," Instruction Book 4914, published by Eastman Oil Well Survey Company.

[4] "Eastman Knuckle Joint," Instruction Book 5018, published by Eastman Oil Well Survey Company.

[5] Discussion by W. W. Moore of the paper "The Need For a Definition of a Crooked Hole," by R. B. McCloy, presented at the 1952 spring district meetings of the API, held in Wichita, Kansas, and Shreveport, Louisiana.

ACKNOWLEDGMENT

Presented at a meeting of the API Mid-Continent District Study Committee on Straight Hole Drilling, Oklahoma City, Oct. 31, 1956.

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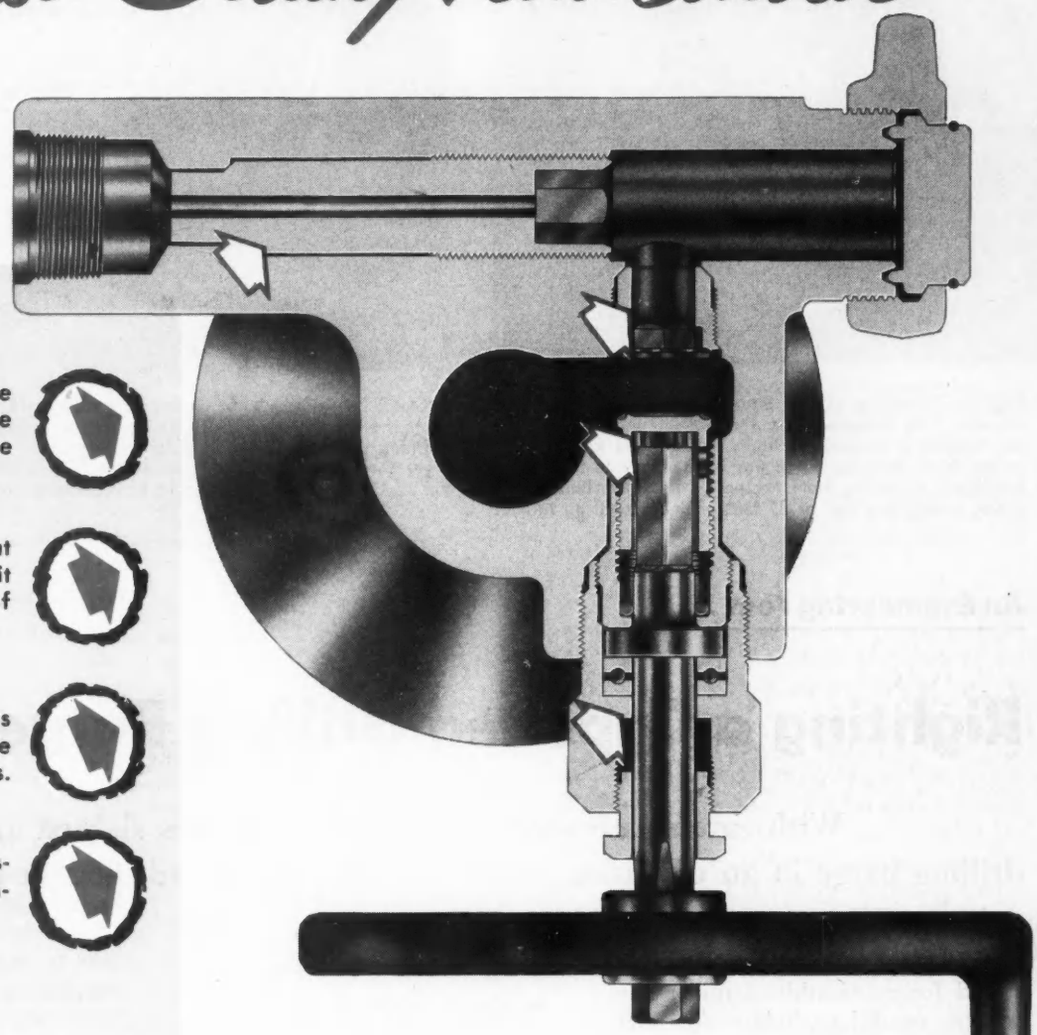

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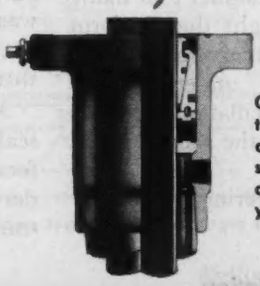

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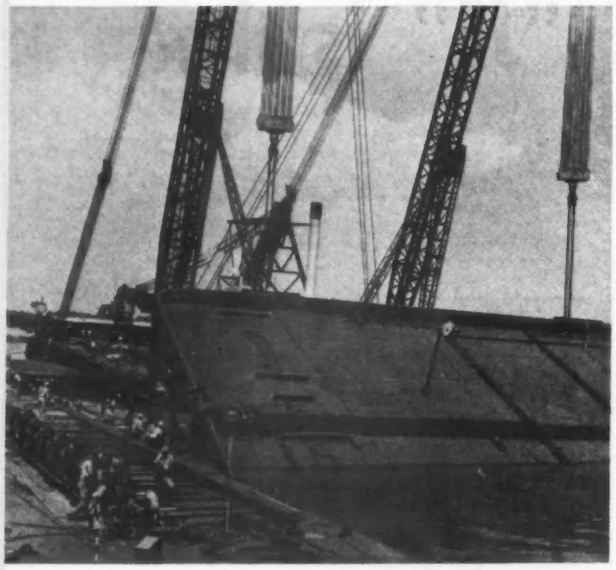


FIGURE 1—Bottom of hull after rotating approximately 45 degrees. Left foreground is the ballast control manifold for flooding or venting the tanks. Manifolding was removed in dry dock after the barge was salvaged. Note the cables and block extending from the port side of the hull to the shore, providing a pull of 75 tons each for righting torque.

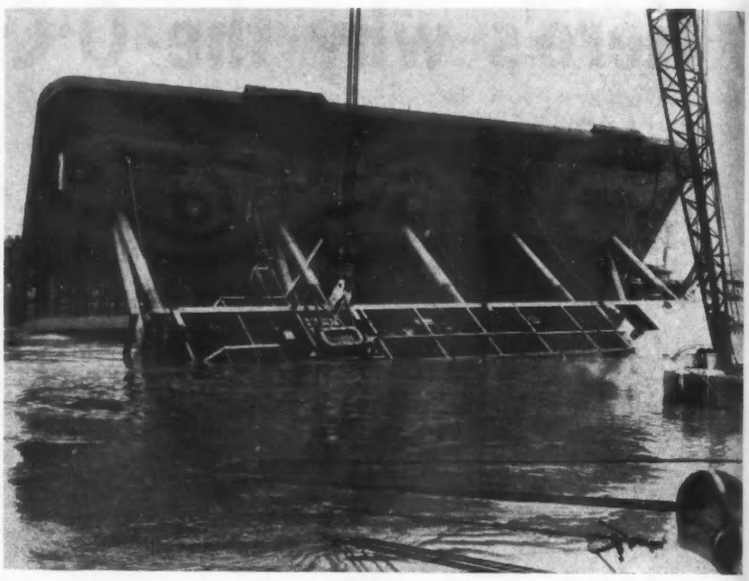


FIGURE 2—Drilling barge in approximately a 75 degree position. Note the special clamps that were devised to fit the columns. These had to be attached by divers working in practically zero visibility in over 60 feet of muddy river water. In the right foreground note the tensiometer that is attached to the dead line so that a constant check could be maintained on the forces in all lines.

An Engineering Feat . . .

Righting a Capsized Drilling Barge

With careful advance calculations, engineers righted and saved a capsized drilling barge in an operation which salvage experts had thought impossible.

ALL OCEAN-GOING vessels are designed for sea-worthiness under most weather conditions. Submersible drilling barges that operate 50 and 60 miles at sea can withstand tremendous wave and wind forces when submerged, but are relatively unstable when afloat. Even under the best conditions accidents do happen. Such was the case when Southeastern Drilling Company's fixed deck, submersible drilling barge suddenly capsized while being outfitted at the Avondale Marine Ways on the Mississippi River.

However, the real story was in the engineering that went into the salvage operations. Despite the fact that many salvage experts thought the platform would have to be cut up for salvage, Avondale engineers undertook the necessary design calculations for salvage that resulted in the success noted on these pages.

The main engineering considerations included:

- Righting Calculations
- Mooring Calculations
- Ballast System
- Calculations for clamps and brackets.

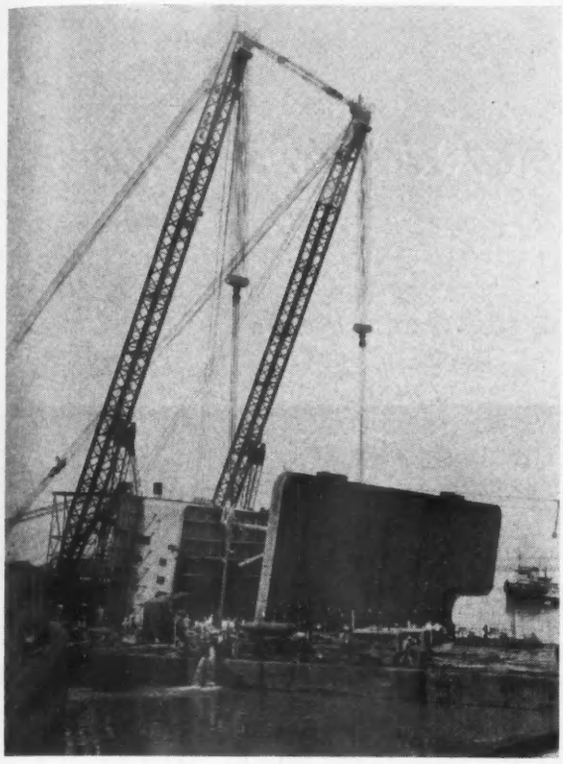
Righting Calculations. Detailed calculations were made through 180 degrees of rotation so that the condition of equilibrium was found for each 15 degrees. In each condition a trial water line was assumed and the buoyancy and center of gravity were determined.

A diagram of all the expected forces was drawn and it was determined that the rotation could be controlled throughout the entire 180 degrees.

After completing all calculations a scale model, 3/16 inch equal to one foot was built using small lead cylinders to similate ballast water. Then using a scale model of the McDermott stiff leg barge the entire salvage operation was rehearsed.

Mooring Calculations. The main function of the mooring design was to carry the resultant of all forces to land. To accomplish this piles were driven next to the wet dock and fastened to the dock. Two large (240 foot x 72 foot x 15 foot) barges, three smaller (135 foot x 40 foot x 8 foot) barges an 800 ton stiff leg barge, a YF and 5 sea anchors and four winches were used to provide the lifting force and the righting moment (Figure 5).

The design external forces on the overturned drilling rig were 750 tons vertically upward from the lifting rig and four 75 ton forces forming a righting couple. The only mooring consideration of the vertical 750 ton force was the change in free board of the 800 ton rig as the load was gradually applied. The resultant of the



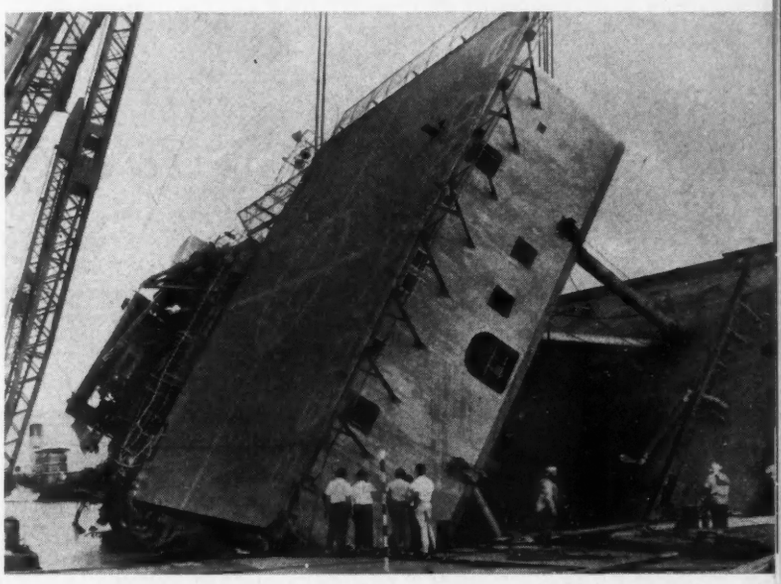


FIGURE 3 (left)—Barge when rotated approximately 105 degrees. Only 750 tons of the available 800 tons lift from the stiff leg was used so that a reserve would be available if necessary.

FIGURE 4 (above)—After about 120 degrees of rotation the topside of the barge can be inspected. Note the damage to the drilling equipment and the mangled safety rails and screens. The derrick had to be cut free. Drill pipe and other loose miscellaneous drilling tools and equipment were later recovered by dragging the river bottom.

righting couple was a force of 150 tons forming a twisting moment of 15,000 foot tons. The moment was taken about the one third point of the ballast control barge. This moment was the main consideration of the mooring design.

Ballast System. The ballast to provide the necessary moment required 6 tanks on the starboard side and 4 tanks on the port side to be worked. These tanks were all wedge or triangular shaped tanks located on the outboard side of the hull. The capacity of these tanks ranged from 11,000 to 23,000 gallons in total volume. They were designed as ballast tanks with a vent height of approximately 19 feet. This vent height plus the tank height provided a total hydraulic head of 30 feet or 13 pounds per square inch. This design set the hydraulic head on the tank which had been tested.

The starboard tanks had to be completely filled to provide the initial list and had to be emptied when the rig was rotated approximately 90 degrees beyond which they would have provided a counter moment. Some of the port tanks were filled but were vented at 135 degrees to prevent too great a righting moment. The ballast tanks were also used to trim the rig and provide equal loading on the lifting cranes.

The principal turning moment to upright the drilling rig was affected by the vertical upward lift applied to the clamp lift fittings at two port ram columns approximately 86 feet apart.

A self-contained clamp fitting was used that could be lowered under water as one unit with the attached derrick lift assembly and not have the closing action of the clamp affected. A screw drive mechanism was designed to close the clamp around the column by means of an impact wrench.

The maximum possible lifting load to be applied on the drill rig structure was computed. Since the deep deck beam was the critical member, the maximum lift load was limited to the beam stress.

Due to precise and exacting engineering calculations the entire operation was conducted on a very exacting schedule that was not allowed to deviate once the operations were under way. Excluding initial preparations the actual salvage operations required only 11½ hours.

—**The End**

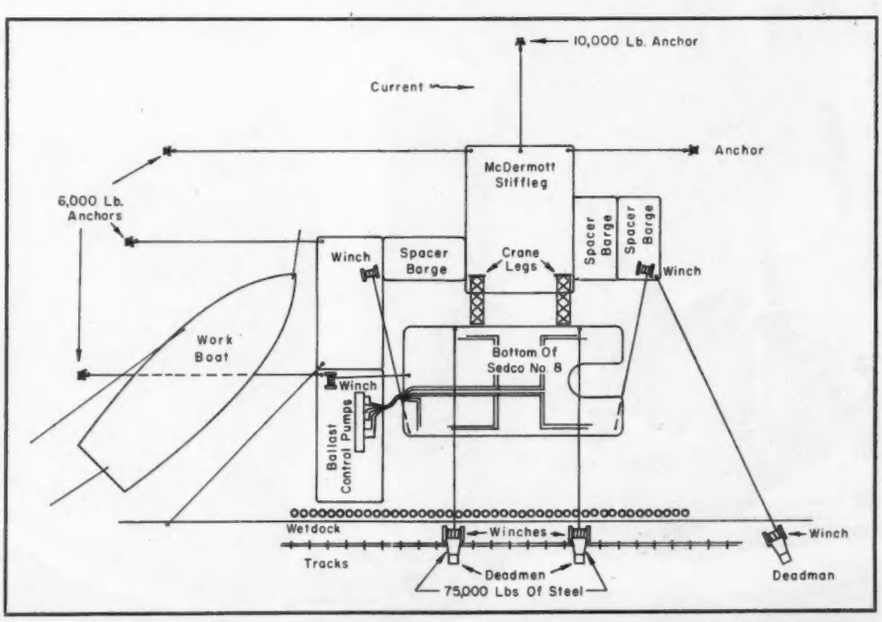
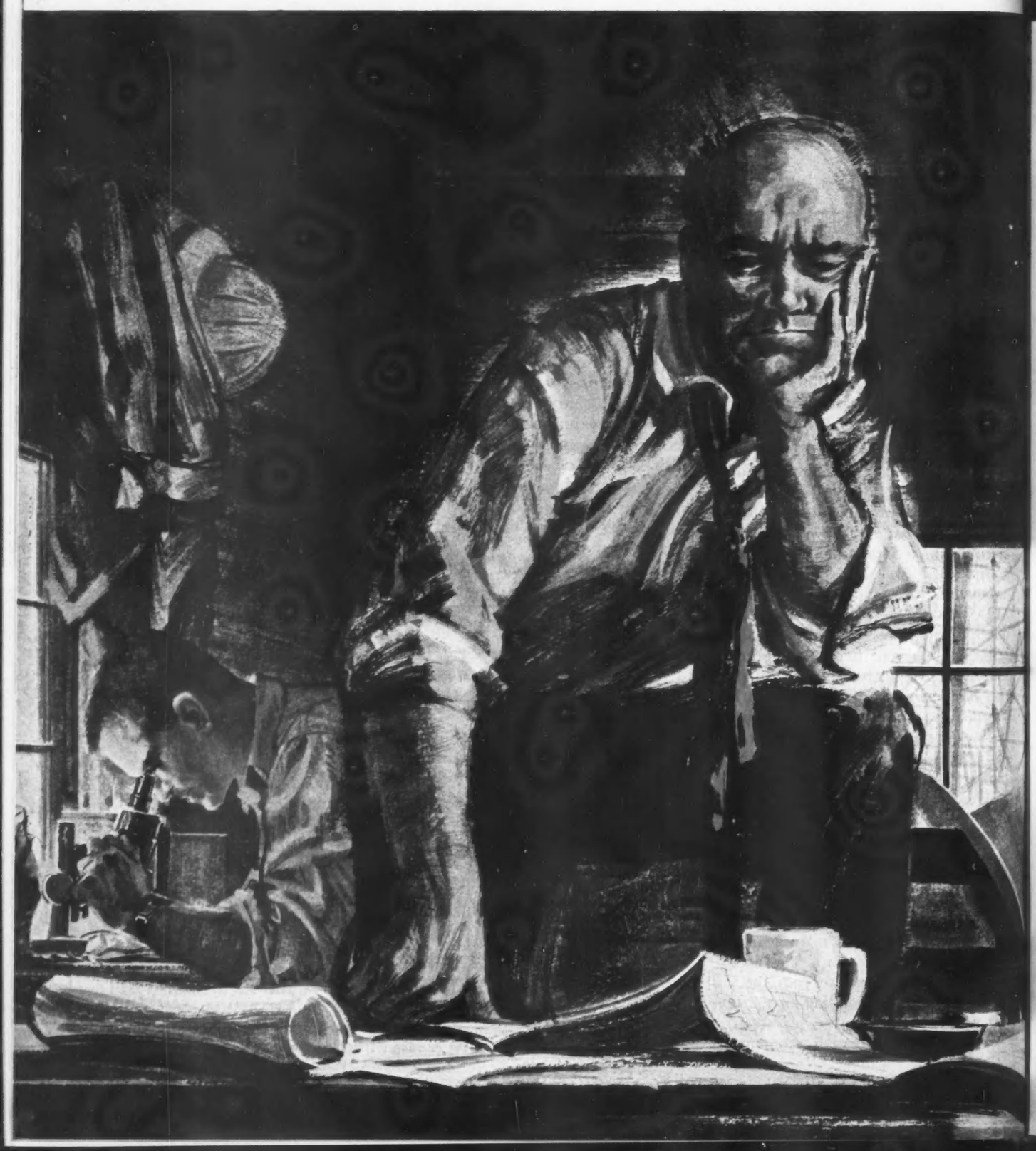


FIGURE 5—A schematic of the mooring system and the barges and lines employed.

To set pipe or not to set pipe. . . .



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THERE'S A DIFFERENCE IN DRILL STEM TESTING . . . AND JOHNSTON MAKES THE DIFFERENCE!

Diesel Electric Transmission

Advantages include flexibility of operation, lower maintenance, and elimination of most alignment problems.

By R. B. BOBISUTHI
Electromotive Division
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LaGrange, Ill.

CONTINUED EVOLUTION of oil well drilling technology has required the development of new, better designed and more efficient drilling equipment. The emphasis today in drilling rig design is on flexibility and portability. As deep well drilling has become more prevalent, power demands on the rig have gone up. The fact that the diesel engine rather than the steam engine is the accepted prime power source on the drilling rig is a reflection of these new requirements. The diesel engine does away with feed water difficulties and is a more compact power package. These characteristics provide greater leeway in rig design and construction. Needless to say, the engine has an excellent performance record in efficiency, economy and reliability of operation.

DRILLER'S CONTROL PANEL showing the additional controls necessary for diesel electric rig operation. Eight position selector switch above the driller's left hand enables him to select the desired arrangement for coupling available generator output to the various motor drive units.

Regardless of the type of prime mover selected, satisfactory means of transmitting the power supplied to the point of use must be provided. The power transmission system must reconcile the inherent characteristics of the prime mover with the inherent needs of the load. While the diesel engine has become more or less the standard prime mover for drilling rigs, the choice of power transmission system is still in a transitional stage.

The obvious and most straightforward means of transmitting the mechanical power output of the diesel engine is to use a mechanical transmission, i. e., clutches, gears, chains, belts, etc. Such a transmission has a number of recognized limitations:

- It is cumbersome.
- It is not responsive to changing load conditions.
- It is inflexible in terms of equipment arrangement.
- It is subject to damage by shock loads.

The addition of fluid couplings and torque converters to the mechanical transmission system is a compromise solution. These devices do provide better shock load absorption and better load response—but the inherent physical limitations of a mechanical system are still present.

On the other hand, an electric transmission system is inherently suited to the needs of the modern drilling rig. It is, after all, an infinitely variable speed changer and can therefore closely match engine output to load requirements. Power is transmitted through flexible cables rather than mechanical torque multipliers and multiple chain drives. Therefore the need for alignment of basic power units with draw works, rotary tables or mud pumps is eliminated and set-up time is substantially reduced.

in Drilling Rigs

The desirability of a diesel-electric power system for the drilling rig has been recognized. But early electric transmission systems were not integrally designed and constructed. The equipment was excessively bulky; an electric transmission was an assembly of various stock components, rather than being integrally designed.

To help drillers fully exploit the advantages of a diesel electric rig, the design of an electric transmission system was undertaken that would be simple to install, operate and maintain and that would provide maximum part interchangeability and maximum operational flexibility.

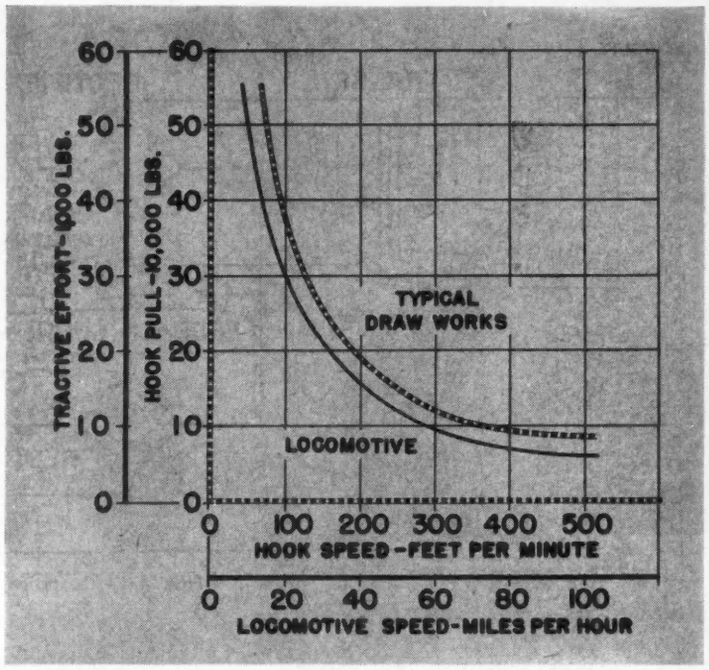

FIGURE 1—Comparison curves of locomotive tractive effort vs. drawworks hook pull.

Load Characteristics. While a diesel engine at full load operates at constant speed and constant torque, the load demand varies, depending upon the equipment to be driven and the operation involved. To properly select the components for the electric transmission, i.e., generators, motors and controls, it is first necessary to analyze load characteristics.

Driving the rotary table is a steady load with little variation in torque or speed so long as drilling conditions are uniform. But if gumbo or heavy strata is encountered and the bit begins to ball, more torque and less speed is desirable. If a "soft" strata is encountered, the converse, higher speed and lower torque output is called for.

The drawworks has a variety of load patterns, depending upon the particular operation. When used as a hoist mechanism for lowering or raising the drilling stem, it represents a traction load. Raising a long stem requires a high starting torque; handling a single stand requires higher speeds and low torque.

Figure 1 shows a typical curve for drawworks hook pull versus hook speed and a typical traction curve for a locomotive. The two curves are almost identical in shape.

Drawworks are also used to power the breaking-out and making-up catheads. Breaking-out or making-up is a low speed, light load operation. The transmission must have good deceleration control so that pick-up speed is not excessive.

Mud pumps are a constant speed load so long as drilling conditions do not vary. However, speed response is desirable if a cavity or plugged hole is encountered.

In view of these load patterns, the design objective was an electric transmission sensitive to load changes and one that could provide extremely high torque at low speeds and low torque at higher speeds.

Power Generation. The prime mover operates best as a constant torque, constant horsepower machine. The function of the electric transmission is to provide variable torque at constant horsepower. Electrically speaking, torque is proportional to current, and speed is proportional to voltage. To maintain constant horsepower, the product of torque and speed must be constant. Therefore, generator voltage must decrease as the current increases.

There are essentially two means of providing this differential effect; either by providing a differential field in the generator, or controlled separate excitation. In choosing the latter course, a smaller and lighter machine than one with differential windings was used. Separate excitation also permitted handling of a multiplicity of load functions without complicating the controls.

The generator that was designed and built for drilling rig applications is a four-pole machine rated at 500 kilowatts. The same machine, except for a change in field winding is used as a motor to power the drawworks, mud pumps and rotary table.

Power Generation Control. An AC power source was chosen for the generator excitation and control circuit so that compact equipment with very low voltage and current requirements could be employed. The driller's hand control is a variable voltage transformer which transforms voltage, rather than a rheostat, which dissipates it as heat. Thus, heat dissipation at the driller's stations is kept at a minimum. The 110 volt AC power supply controlled by the variable voltage transformer goes through a step-down transformer and is then rectified. The rectified current is supplied to the field of the diesel engine-driven exciter generator, which amplifies the excitation current to the main generator field.

Automatic current voltage control is provided by a feedback circuit inserted in the power circuit between the generator and motor, shown in Figure 2. Heart of this circuit is a transductor—a device consisting basically of a steel core with coil wind-

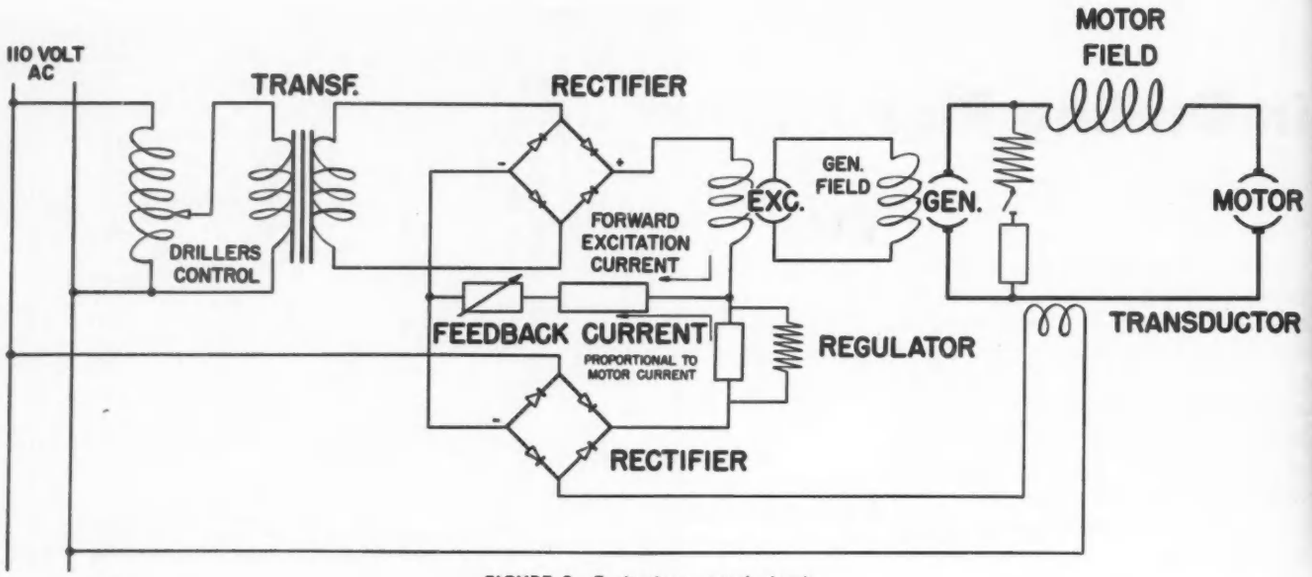

FIGURE 2—Excitation control circuit.

ings. The coil windings are supplied by a small AC current from the 110 volt supply and a rectifier is connected on the output so that the feedback current is DC.

The transductor is mounted so that the DC load cable from the generator to the particular motor involved passes through its core. Little current flows through the transductor because of winding impedance. But when the load current in the main DC cable picks up, the transductor core saturates, changing its impedance and allowing an increase in the transductor output.

The DC current from the transductor flows to a pre-set resistor and the voltage drop produced subtracts from the voltage on the exciter generator field. The result is a reduction in exciter field current and thus less voltage generated by the main generator.

With the addition of a simple field regulator, the control system is also able to provide automatic torque and thermal supervision. Torque limitation provides protection for equipment being driven when the generator is used intermittently. Thermal limitation prevents load motor overheating during continuous generator output. The field regulator has two coils; a current coil for torque limit, and a voltage coil which, in combination with the current coil, provides the thermal limit.

The current coil is in series with the transductor output and acts to produce a bucking voltage drop when the load current approaches 1000 amps. The voltage coil is wired across the generator output so that as the generator voltage rises, the voltage coil causes resistance to be cut into the exciter field circuit. A recalibration relay is arranged so that when an individual generator is used to power an intermittent load, such as the cathead, the relay cuts out the action of the voltage coil. This causes a change in the generator characteristic to match the operating requirements of the equipment involved.

Control System Results. By using four simple, low cost and relatively static control components, namely: transductor, rectifier, field regulator and resistors, together with a relatively small generator, characteristics are obtained of a system that otherwise would have required larger and more expensive and complex equipment.

The generator characteristic curves reflecting the net results of the control system are shown in Figure 3.

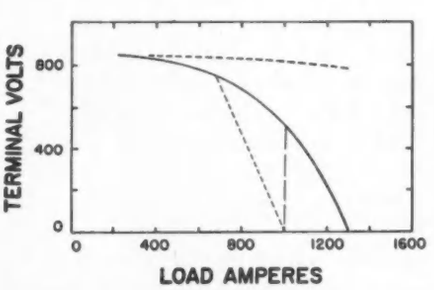

FIGURE 3—Generator characteristic curves that reflect the net results of the control system. (See text for a description of the individual curves.)

The horizontal broken line (at the top) is the generator characteristic resulting from a given excitation without control. The solid line shows the differential effect of the feedback current. It is a close approximation of the constant power curve desired for drill rig generator operation.

The vertical broken line represents the control effect of the field regulator current coil on intermittent generator output to limit torque.

The diagonal broken line (short dashes) represents the continuous generator output obtained as a result of the control effect of the current and voltage coils of the field regulator. As can be seen, the volt-amp relationship is a straight line whose slope can be varied by varying the relationship between the current and voltage coils of the field regulator.

The generator and control system offers unusual flexibility in performance. Generator characteristics can be adjusted by relatively simple circuit changes to meet the sometimes widely varying needs of mechanical equipment used on drilling rigs.

Load Motor and Control Design. Having satisfactorily converted the mechanical power output of the diesel engine into conveniently handled electric power, we come to the reconversion of the electric power to mechanical power with the design of the load motors and controls.

As is well known, there are two basic types of direct current motors, the series motor and the shunt motor with its variation and the separately

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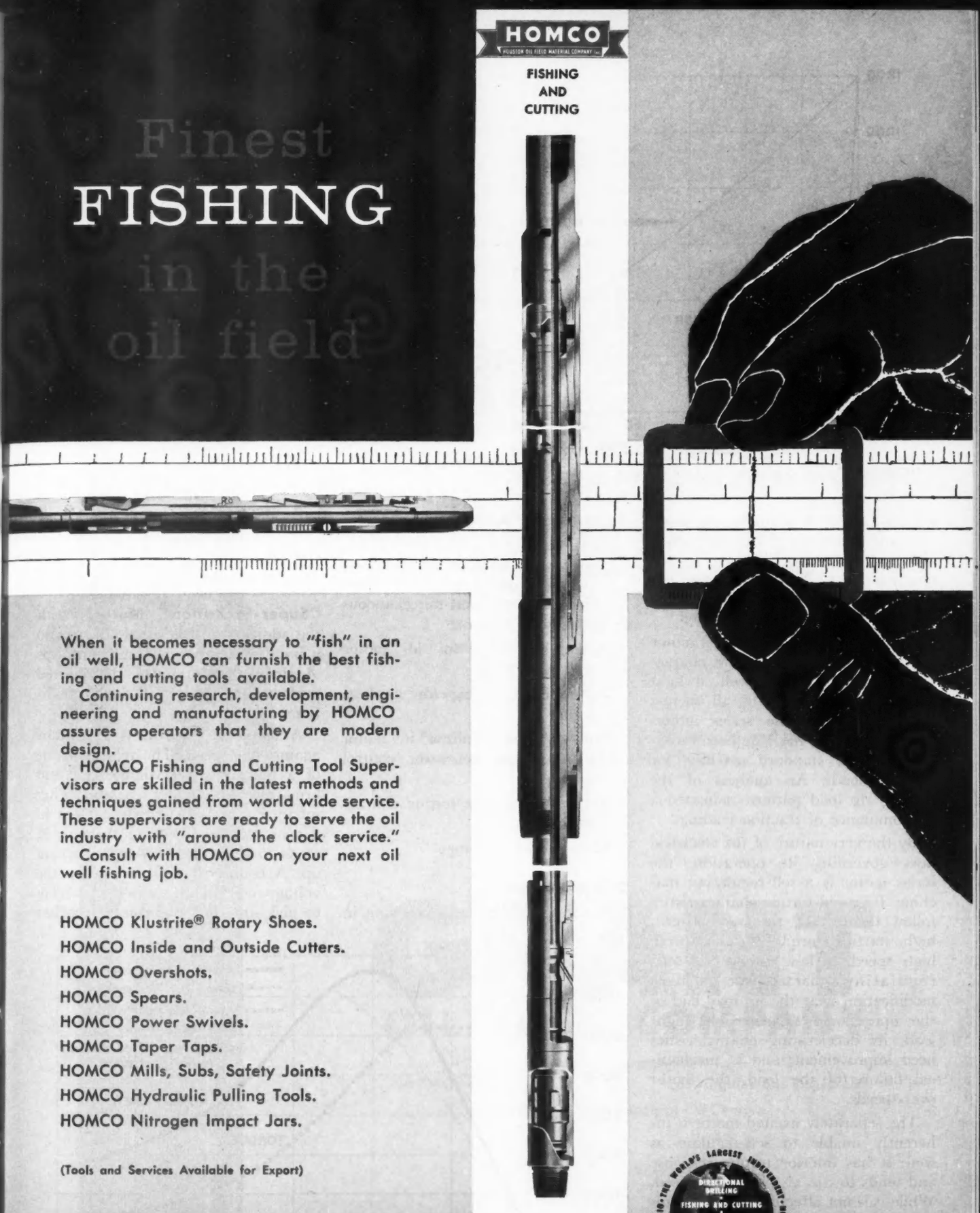

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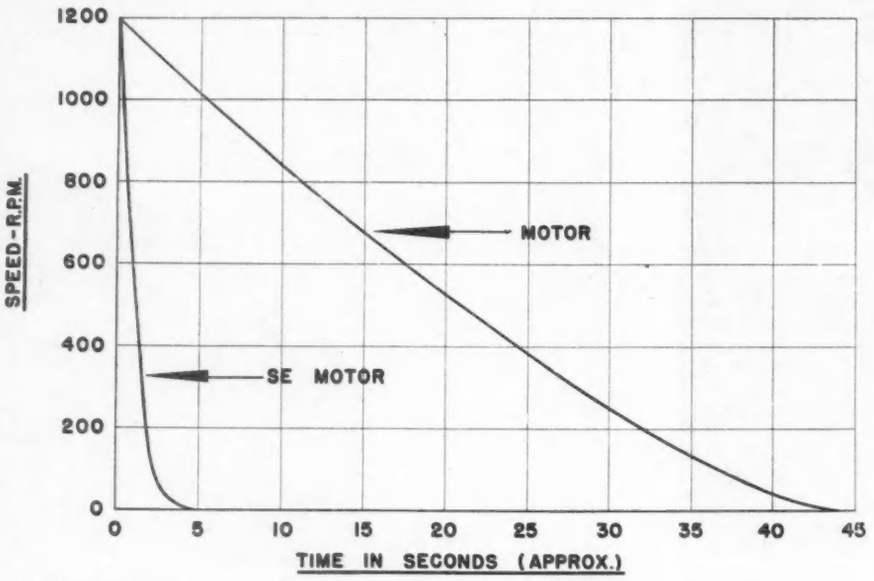


FIGURE 4—Typical drawworks deceleration curve for regular and super excitation motors.

excited motor. A shunt motor has a constant speed and a varying torque and has very poor starting torque characteristics. To provide the desirable starting characteristics a separate excitation supply is required.

While the separately excited motor does have good decelerating characteristics and performs well at light load, a consideration of all factors strongly favored the series motor. The series motor has long been recognized as the standard machine for traction loads. An analysis of the drilling rig load pattern indicated a predominance of traction loading.

By the very nature of the electrical laws governing its operation, the series motor is a self-regulating machine. Its speed-torque characteristics follow the drilling rig load pattern; high starting torque at low speed, high speed at low torque. Its self-regulating characteristic requires modification near the no load end of the operational sequence. At light load, its decelerating characteristics need improvement; and at mechanical failure of the load, the motor over-speeds.

The separately excited motor is inherently unable to self-regulate as well; it has inferior torque response and tends to run at a constant speed. While it is not affected by a mechanical loss of load, it must be protected against an electrical (field) failure which would cause it to "run away." To sum up, the following are the advantages and disadvantages of each type.

Series Motor Advantages:

1. Speed-torque characteristics suited to the needs of the drawworks, mud pumps, rotary table and auxiliary and miscellaneous drives.
2. Standardization of all motor drives.
3. Simplified wiring for application.
4. Controls centralized in motor control and generator control cabinets.
5. Higher inherent torque characteristics.
6. Wider speed range.

Disadvantages:

1. Safety control for speed limit in case of load loss due to mechanical failure.
2. Deceleration control for performance improvement.

Separately Excited Motor Advantages:

1. Will not overspeed with loss of load.
2. Better inherent decelerating characteristics.

Disadvantages:

1. Speed-torque characteristics do not match load requirements, consequently the motor does not respond well to changes in drilling conditions.
2. Requires voltage failure protection for each motor field.
3. Machine transients need to be controlled.
4. Three kw per motor is required for control power.

"Super-Excitation" Motor. With the addition of two simple devices to a basic series motor, a machine was obtained that provided the desired performance under all load conditions.

A simple relay protects the motor against overspeed. The relay consists of a magnet yoke, voltage coil and armature and contact assembly. Flux set up in the yoke by the current in a generator lead passing through it, tends to keep the relay from picking up. A counter-flux is set up by the voltage coil which causes the relay to pick up when the voltage reaches

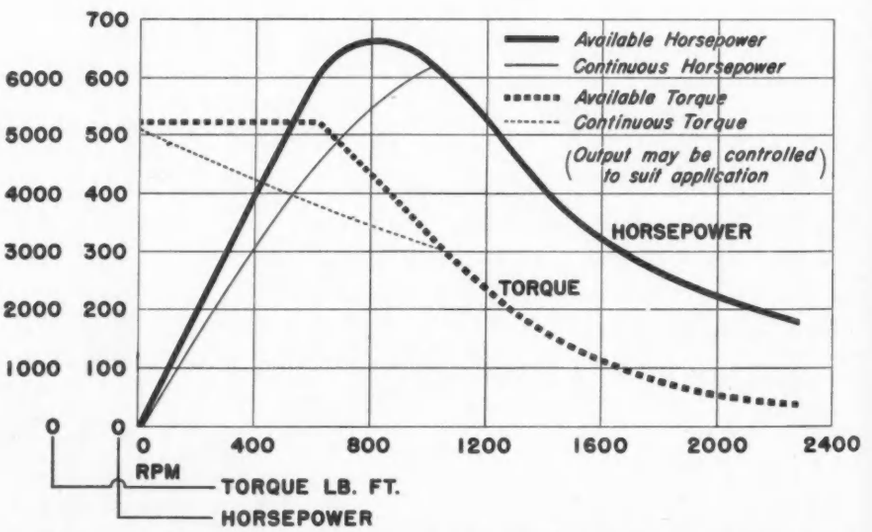
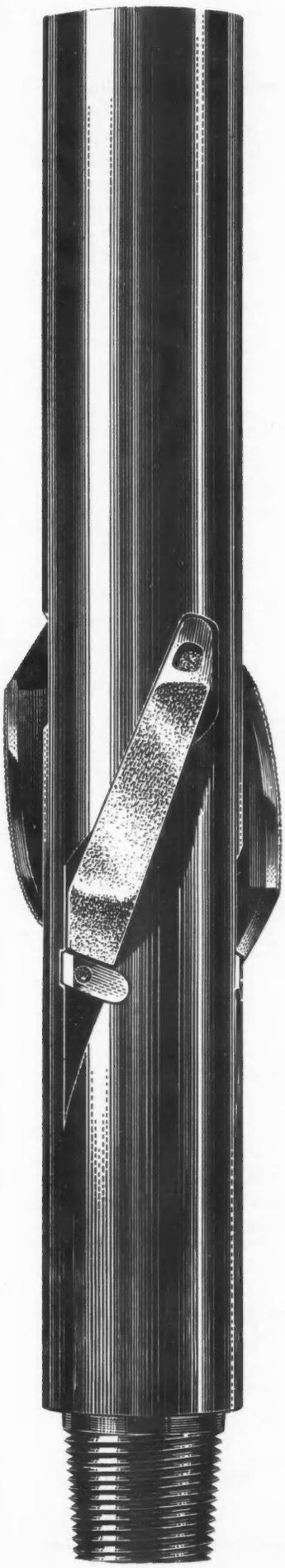


FIGURE 5—Industrial motor torque and horsepower curve for applications form 150 to 625 horsepower



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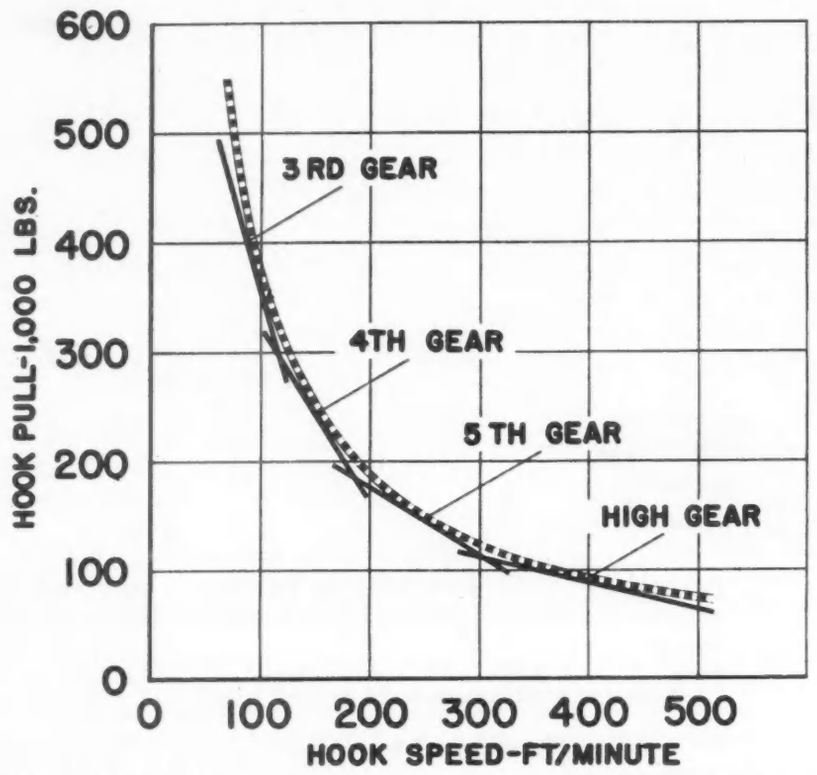


FIGURE 6—Typical 1200 horsepower drawworks curve compared with theoretical "ideal" curve.

an overspeed value for a given load.

Improved deceleration characteristics are provided by a compact unit with no moving parts and with components that have a long life. Designated as "Super-Excitation Control," it consists, in effect, of a selenium rectifier and a step-down transformer supplied from the 220/440 AC utility system of the drilling rig. It maintains a small amount—approximately 20 percent—of excitation in the motor field.

So long as the normal excitation is at an appreciable value, the device does not materially affect the motor characteristics. It comes into play only when the normal excitation drops to the point where it is in the magnitude of the super-excitation current. The effect of the super excitation is to make the motor become a generator and drive the main generator and engine. By thus converting the inertia of the motor and its load into electrical energy which is in turn dissipated in the main generator and engine, the "Super-Excitation Control" slows the armature quickly and smoothly.

Figure 4 shows the effect of the "Super-Excitation" control on the operation of the electric transmission. Figure 5 shows the torque and horsepower curves for the industrial motor. Figure 6 shows the optimum drawworks curve and operating curve for a typical drawworks application.

The curve in Figure 7 illustrates a typical application of two motors to a mud pump rated at 1000 input horsepower. Maximum pump output is shown by the dashed curve and is obtained by adjusting the speed control knob to give full horsepower over the entire operating range of the pump.

The Integral Diesel-Electric Unit. Starting with the two-cycle V-type, eight cylinder, 875 horsepower diesel engine as the prime mover together with the basic components of the electric transmission previouly described, a drilling rig power package can be asembled to meet the particular needs of the rig operator. A typical power plant would consist of the following:

1. One or more skid mounted engine generator sets, shown in Figure 8, each equipped with two dual drive individually controlled DC generators.
2. A separate skid mounted motor control cabinet which houses all motor switching and protective equipment.
3. The driller's control panel containing all operating controls and alarm indicators in a compact cabinet which can be mounted integrally with the drawworks clutch and brake controls.
4. Drive motors mounted integrally with the driven equipment.

A typical field arrangement of the power plant is shown in Figure 9. In this case dual drive motors are used on two mud pumps and the drawworks while a single motor drives the rotary table. The eight position "selector switch" located on the drill-

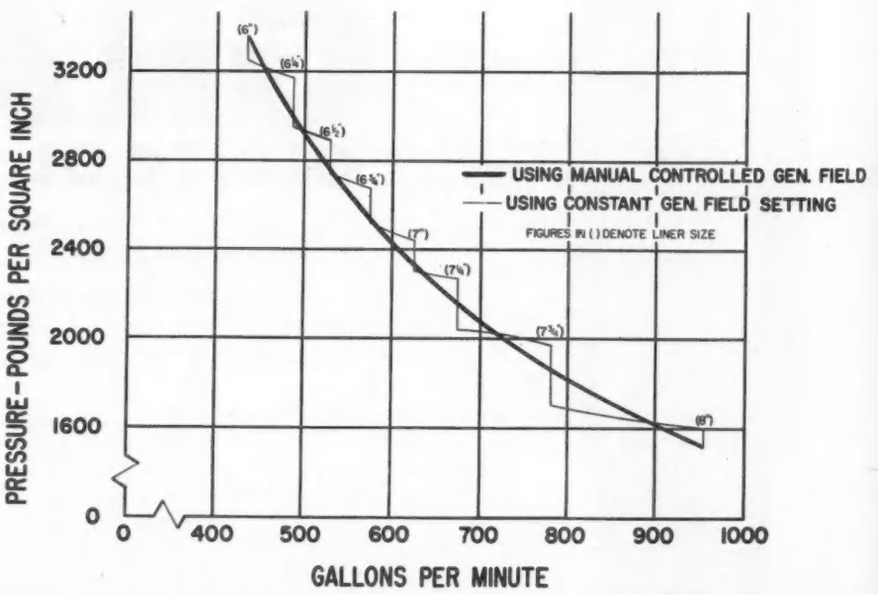
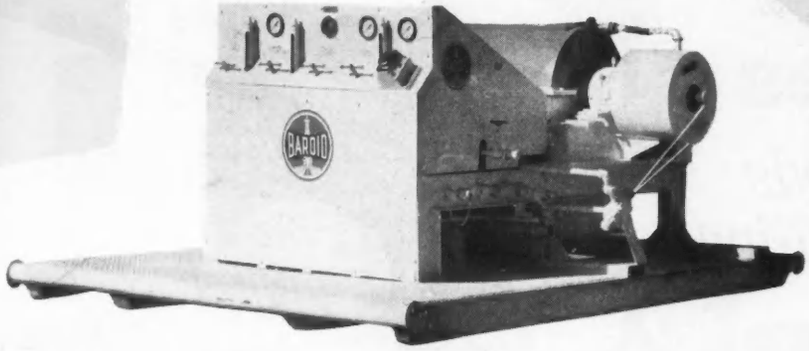


FIGURE 7—Typical 1000 horsepower mud pump application curve using 2 motors.



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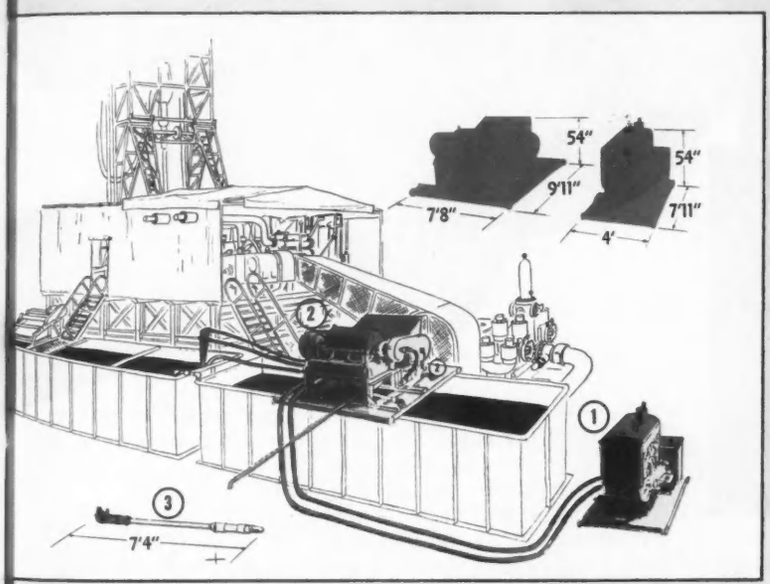

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Other features include high-capacity roller bearings throughout; husky all-steel fluid end, easily serviced; and forged-and-rolled gear rim, which is replaceable in the field. This is only a partial list, of course; there are still other points that merit careful study by the prospective buyer.

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G-65	8 x 16	650
G-85	8 x 18	850

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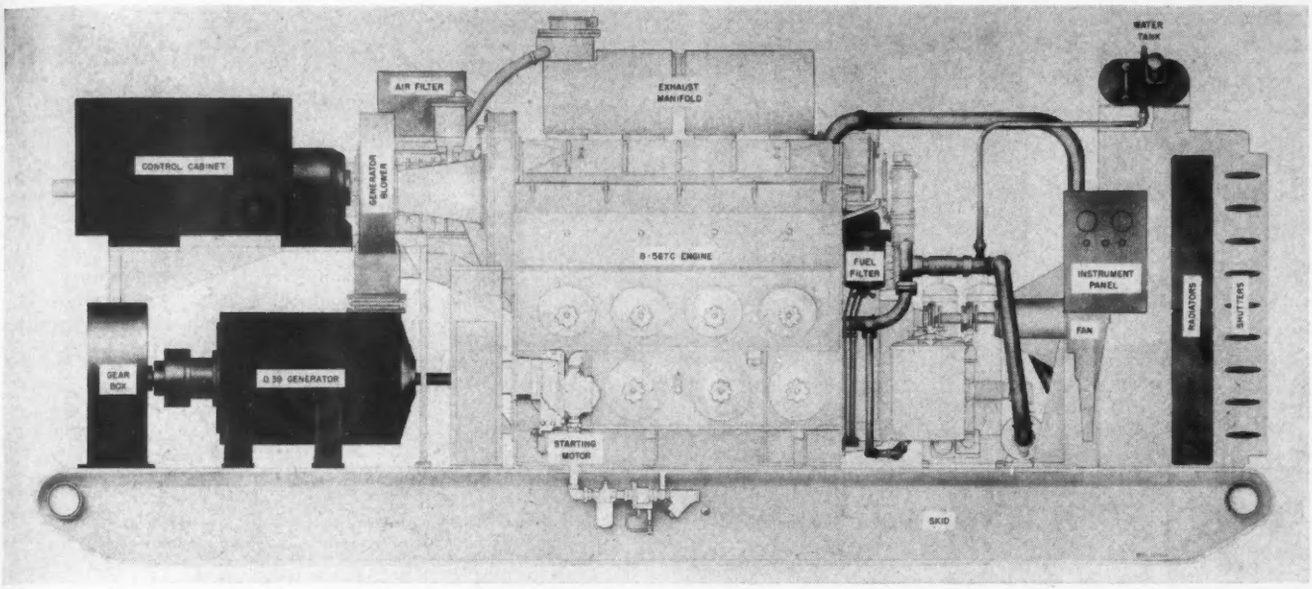


FIGURE 8—Skid mounted, two-cycle, V-type diesel engine with the basic components for power generation and transmission.

SPECIFICATIONS Engine: 8 cylinder, rated at 875 horsepower at 835 rpm. Generator: Two generators, each rated at 500 K.W. Total Weight(Dry): 53,000 pounds. Dimensions (Over-all): Length 25 feet, width 7 feet, 10 inches, height 10 feet.

er's control stand selects the desired arrangement for coupling available generator output to the various motor drive units. For full torque, low horsepower operation, a single generator is connected to the individual motor drive. For full torque, full horsepower operation, two generators are connected in series to the motor drive unit.

Field Experience. Integrally designed diesel electric units have probably not been in operation on drilling rigs for more than one or two years. Yet even in that short time interval the electrical transmission has proven to be of great merit.

On a mechanical rig, the operator becomes aware of a stuck bit or pipe when it breaks off under the stress. But with an electric transmission, the motor slows down if overloaded, and the resistance can be "read" off the dials of the generator. Because peak power is obtained when the throttle is hit, it isn't necessary to "rev up" the engines and throw in the clutch to pull a heavy string of pipe.

With prime movers grouped on the substructure of a rig, vibration tends to loosen structural bolts. On a diesel electric unit, the engine and generator can be placed completely off the rig; the motors are relatively free of vibration. The ability to separate the power source from the power use has proven to be highly desirable. In offshore work some operators have put the engines and generators on tenders, and left one generator set on the drilling platform to supply service needs. It is possible to put the drawworks on the ground rather than on the floor of the rig. As a result, the whole substructure can be lighter and cheaper.

Because the entire alignment problem is done away with, a diesel electric rig can be laid out with far greater flexibility than a mechanical rig. By merely using longer or shorter cable, equipment can be placed at the most convenient point. One rig operator placed the electric motors driving the drawworks on the drawworks skid to permit it to be moved to any position on an eight-well platform without regard to the generator sets.

Potential developments in oil well drilling will make the application of electric transmissions even more desirable. These developments include an electric bottom-hole drilling motor —an idea that has been on the drawing boards for some time; and packaged drilling units in which an electric motor is integral with the drawworks, pumps and rotary tables.

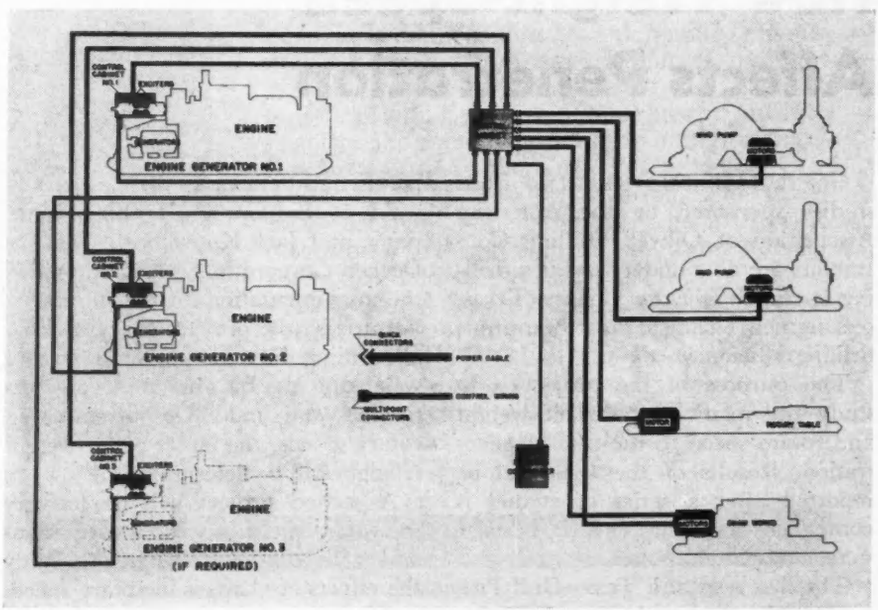


FIGURE 9—A schematic drawing of the field arrangement of a diesel-electric power plant.

—The End

ELECTRIC RECORDERS used in AAODC weight-speed vs. penetration field studies in Ector County, Texas. Two-channel recorders, left, registers pump speed and pressure. Four-channel instrument records torque, total hook load, rate of penetration and rotary speed. Engineers B. C. Groenwold (left) of Exploration Drilling Company, and Jack Knowlton, Martin-Decker Corporation, supervise the test procedure.

How Weight-Speed Affects Penetration

CONTROLLED ENGINEERING field studies sponsored by the American Association of Oilwell Drilling Contractors are now under way at a drilling operation in Ector County, Texas, seeking new technical data to improve drilling efficiency.

The purpose of the project is to study the relationship of bit weight and rotary speed to the rate of penetration. Results of the tests will be reported after a series of studies is completed, according to E. L. Decker, subcommittee chairman.

The first tests at a Texas Gulf Producing Company drilling location near Dora Roberts pool, located six miles south of Odessa are being supervised by engineers B. C. Groenewold of Exploration Drilling Company, and Jack Knowlton of Martin-Decker Corporation, which provided the instrumentation for the studies.

Initially, the project will be to hold all drilling functions constant except weight on the bit and in various formations and under various stabilized rotary speeds, the effect of bit weight changes will be determined.

A second project will be to vary the rotary speed in various formations and with different weights to study the effects of changes in rotary speed.

After these relationships have been established, work will be done with the product of weight times speed. This product will be kept constant through changes of bit weight and rotary speed to determine its relationship to rate of penetration.

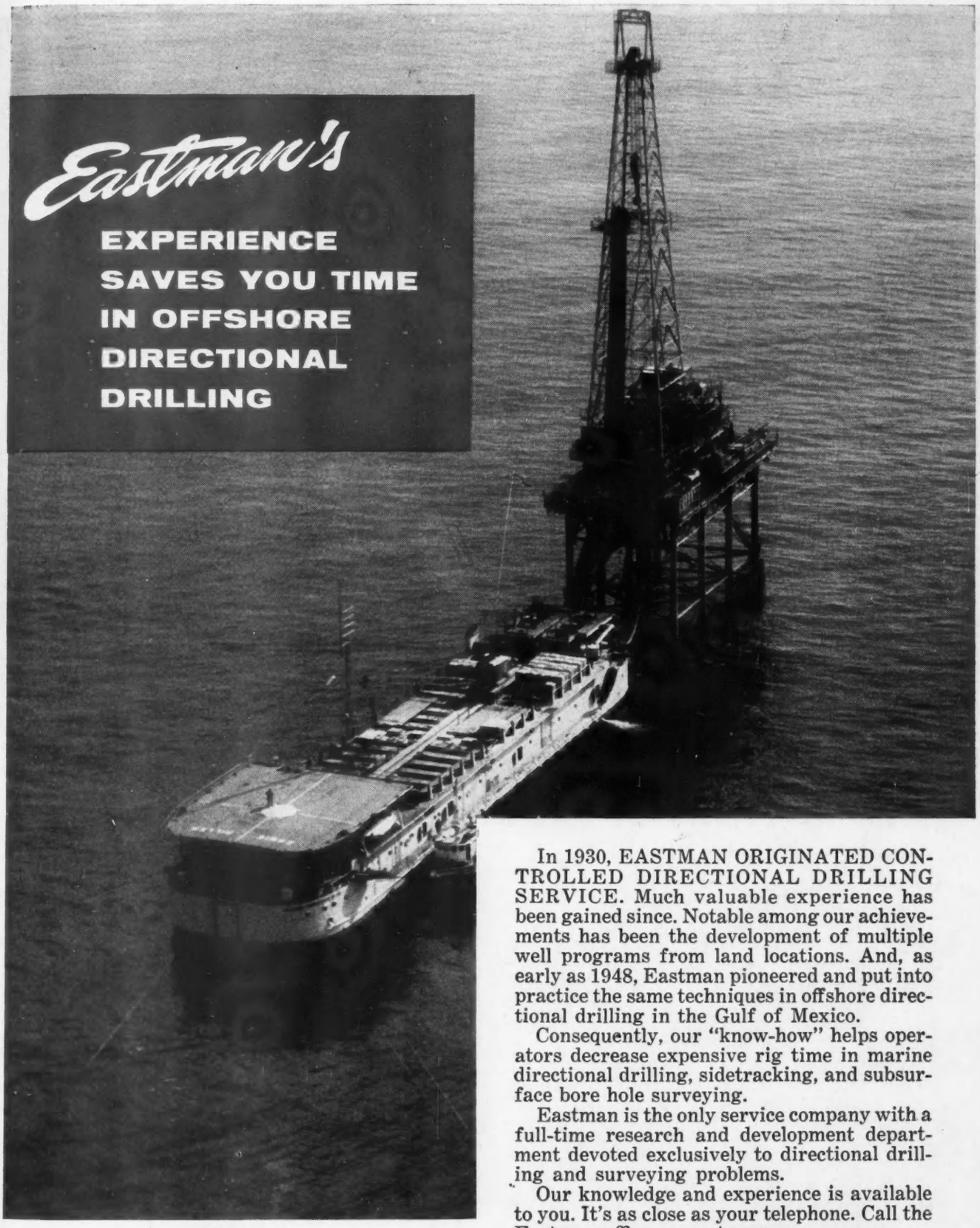
The measurements are recorded on two instruments mounted in the dog house 150 feet away from the rig floor. The two-channel recorder registers pump speed and pressure while the four-channel instrument records torque, total hook load, rate of penetration and rotary speed.

Signals for the recordings are taken from instruments on the rig floor, and through transducers are altered to electric signals which are then relayed through electric cord to the recorders.

Each day a length of the continuous strip charts is torn off and studied by the engineers. Results of the day's tests are evaluated and plotted on graphs.

William P. Clements, Jr., Dallas, chairman of the AAODC rotary drilling committee, said the weight-speed versus penetration project is one of several field practice studies now being conducted by AAODC in the search for better drilling methods.

—The End



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Evaluation of Counterbalance Methods

It has been estimated that 70 to 80 percent of all pumping wells are out of balance. How good is your balancing method?

By KENNETH N. MILLS, Consulting Engineer, Tulsa

THE IMPORTANCE of accurately counterbalancing a pumping unit cannot be over-emphasized. This is especially true as the load approaches the peak torque capacity of the unit. When properly balanced, the speed reducer and engine loads are at a minimum. Any deviation from this condition increases the load imposed on these elements. Proper counterbalance can be attained with either beam, rotary, or air counterbalance as each of these systems stores up energy on the down stroke and restores it to the system on the up stroke.[1]

All API pumping unit speed reducers are designed to give years of trouble-free service when loaded within their capacity. Field experience indicates that relatively small overloads will materially reduce their life. For example an overload of 20 percent will reduce their life to a few years, and overloads of 50 percent usually cause failure in a few months. The usual types of geared speed reducer failures resulting from overload are gear tooth breakage, Figure 1, and destructive pitting, Figure 2. The gear shown in Figure 2 operated 60 days under an overload of approximately 40 percent. The final result was tooth breakage failure which occurred in 120 days. The performance of this and many other overloaded reducers illustrates the importance of proper application and counterbalance. A counterbalancing error of 20 percent on a capacity loaded reducer will create an overload of 20 percent. Improper counterbalance also causes excessive engine and "V" belt maintenance and excessive power consumption on electrically driven units.

Units Out of Balance. It is quite common to find units operating out of balance. One investigator[2] reported that between 70 and 80 percent of all pumping wells are out of balance. A high percentage of these units are lightly loaded and will not suffer reducer failures. However, many will require excessive engine maintenance and will waste electric power.

Several "practical" methods for evaluating counterbalance have been advanced and are in rather common

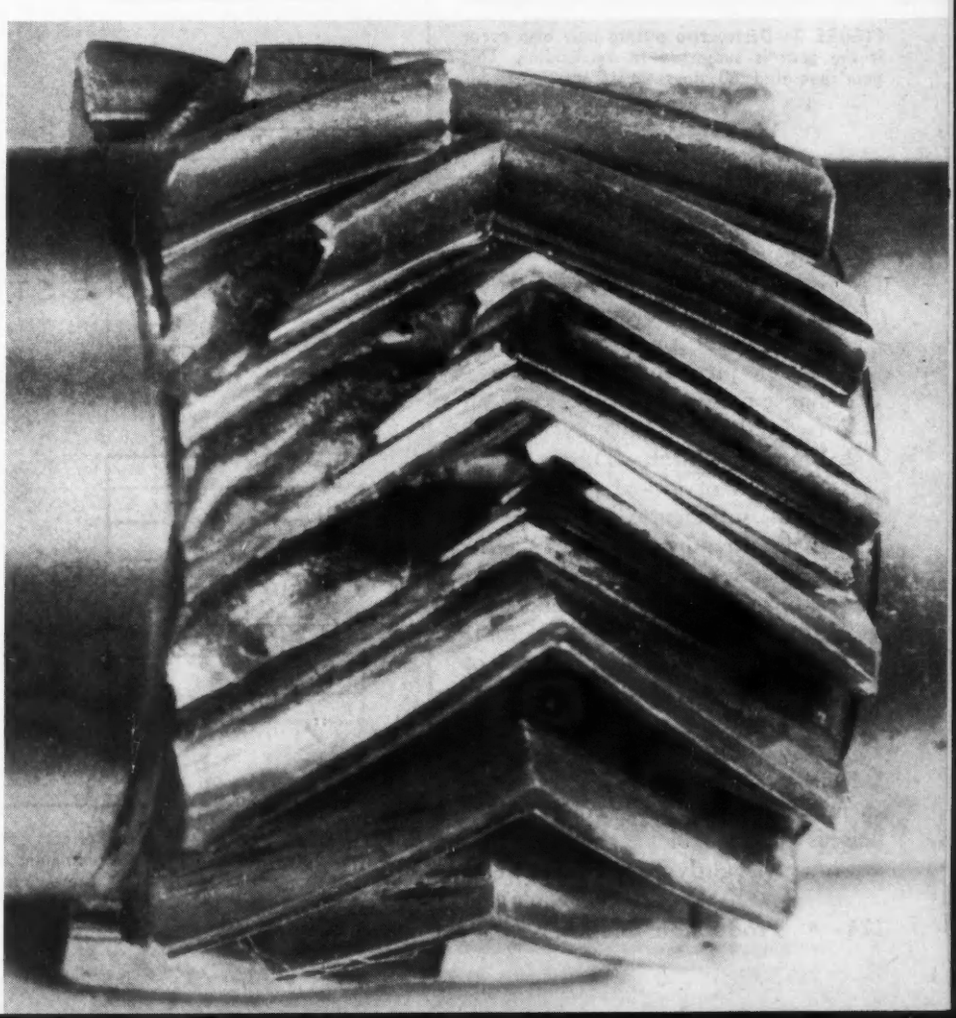


FIGURE 1—Gear tooth breakage is one of the results of overloading a geared speed reducer. This helps to illustrate the importance of proper counterbalance.

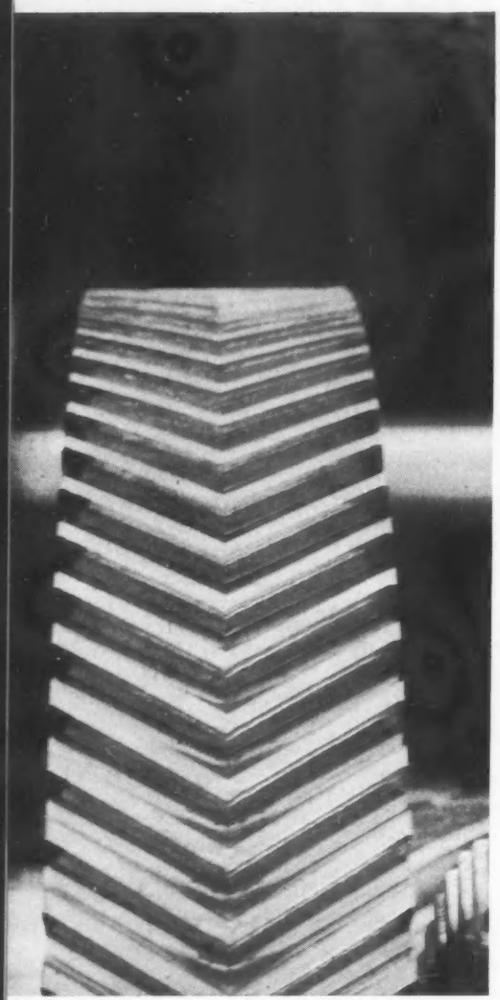


FIGURE 2—Destructive pitting may also occur if the gear is subjected to overloading. This gear operated 60 days under a 40 percent overload.

use. The two most reliable of these practices are:

1. **Engine Exhaust**—If engine is exhausting unevenly with heavy explosions occurring regularly on either up or down stroke, then unit is not properly balanced. When properly balanced, exhaust noise will be the same on two halves of stroke cycle.
2. **Slipping Clutch**—Throw clutch lever out of locked position and hold sufficiently engaged to maintain pumping speed. Then gradually release until slight slippage occurs. This will occur at point of greatest torque. If slippage occurs on both halves of stroke cycle, unit is in balance. If slippage occurs on up or down stroke only, unit is out of balance.

Neither of these methods are exact. In most instances the engine exhaust noise is most reliable, because clutches are usually slightly gummed and tend

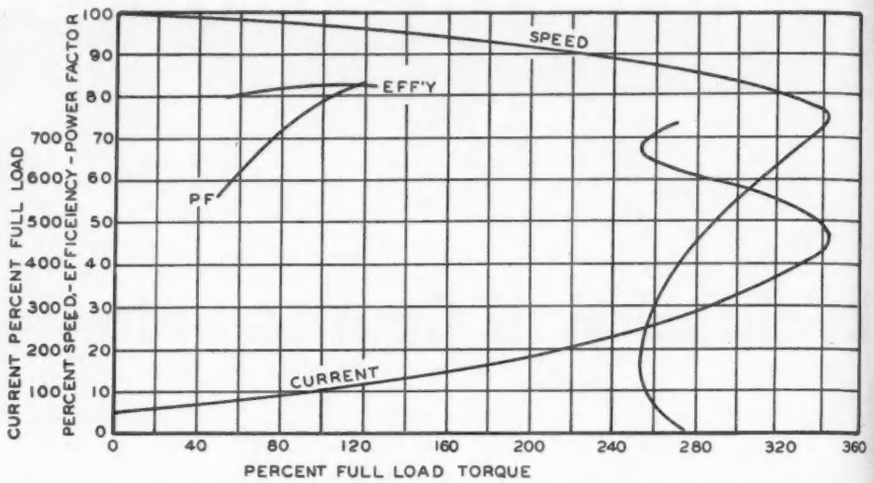


FIGURE 3—Here is a diagram of the typical characteristics of a high-speed general purpose motor. Note that the current is a function of torque load and increases with torque.

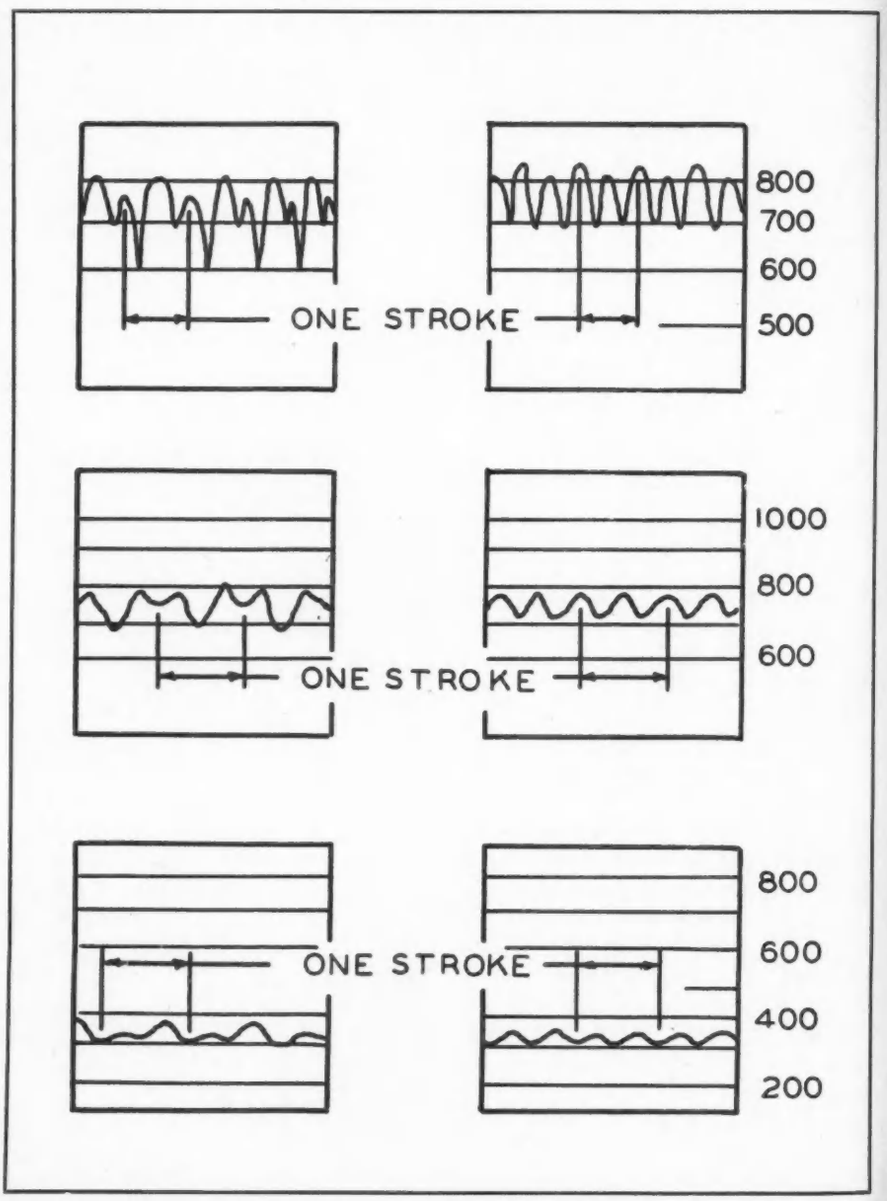
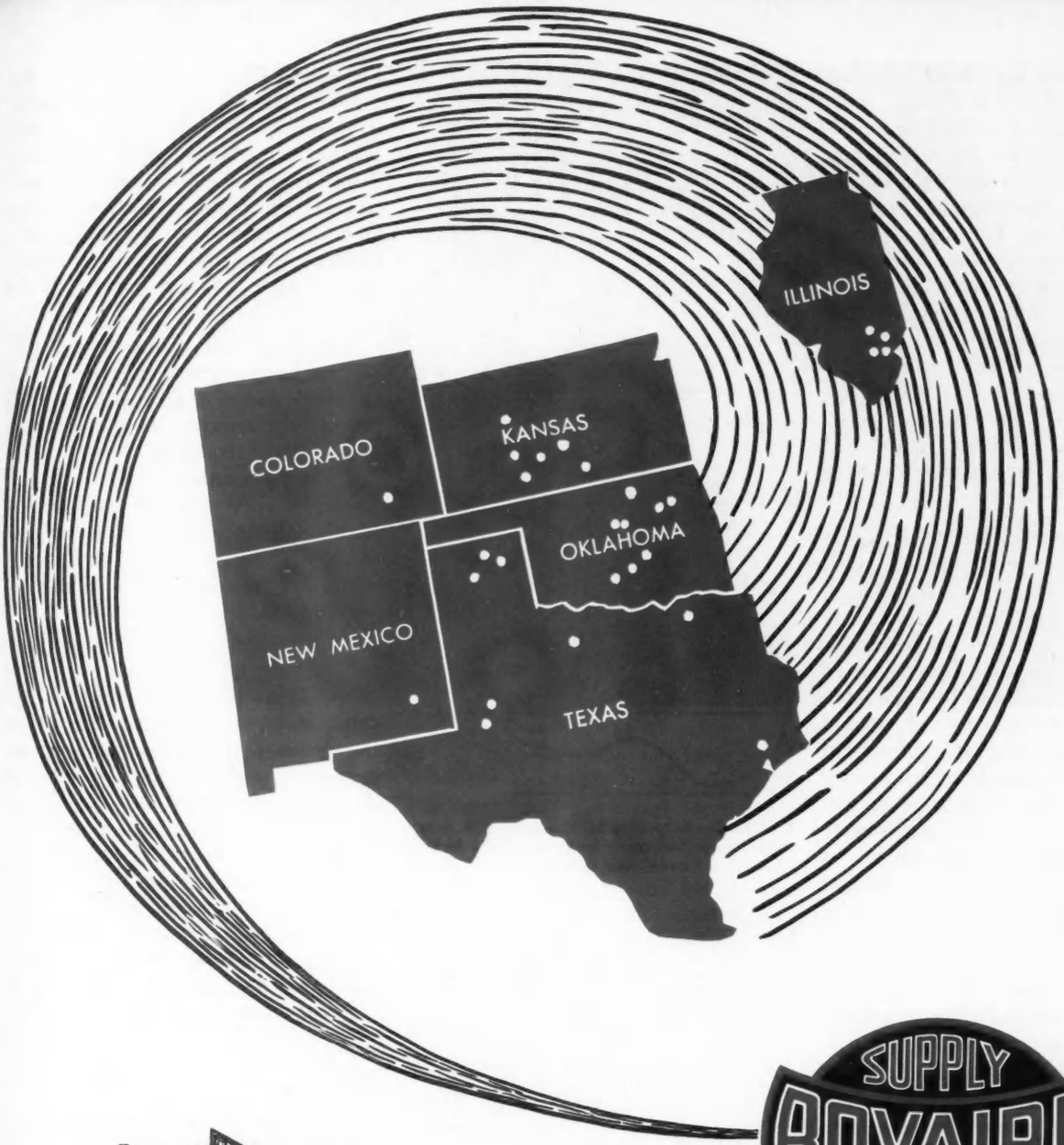


FIGURE 4—Tachometer charts show effects of balancing by using fluctuations in engine speed as an indication of load. When the minimum engine speeds on 2 halves of a stroke are equal the unit is in balance.



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to grab, making the clutch slipping method very difficult to apply.

Three instrument methods for evaluating counterbalance are in common usage. These are recording tachometer, clip-on ammeter, and polished rod dynamometer. The first two use comparative measurements of characteristics indicating prime mover load, and the latter the difference between well load and counterbalance effect as measured at the polished rod to evaluate balance. The dynamometer has the disadvantage of requiring accurate field work and involved calculations to achieve reasonably accurate results.

Clip-on Ammeter Is Most Accurate. If the unit is electrically powered, the clip-on ammeter is the most accurate, because it gives an accurate indication of instantaneous power input. Typical electrical characteristics of a high torque general purpose motor are shown in Figure 3. It will be noted that the current is a function of torque load and increases with torque. Therefore, it is a good indication of relative pumping unit torque load, and when the peak current is equal on both halves of the stroke, the unit is in good balance.

The recording tachometer method uses fluctuations in engine speed as an indication of load, and assumes that when the minimum engine speeds on the two halves of the stroke are equal, the unit is in balance. Some typical recording tachometer charts taken before and after balancing are shown in Figure 4. As this method does not consider throttle opening and engine inertia, it is not absolutely accurate. When the engine speed decreases, the throttle opens and increases the power output. The rotating inertia of the engine tends to keep it running at a constant speed and decreases in speed release some of this energy to the system.

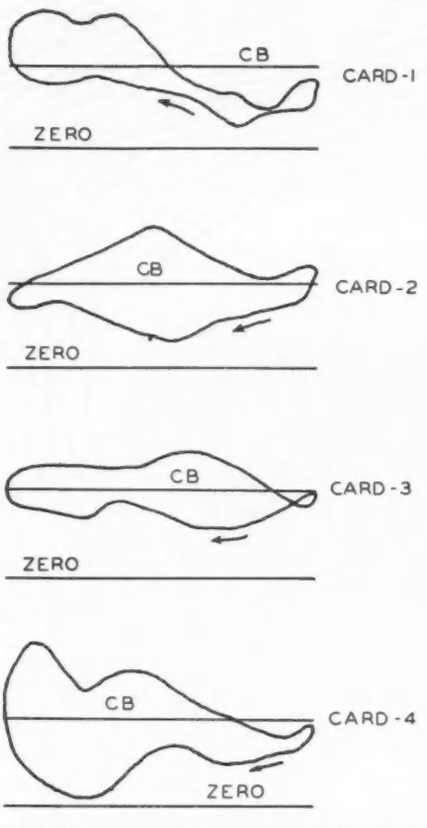

FIGURE 5—According to the simplified dynamometer method these loads should be in balance—but are they?

The magnitude of the error resulting from these factors is dependent on the cyclic nature of the pumping unit's power requirements. If the instantaneous power requirements were identical on both halves of the stroke, it would be very accurate. In most instances these requirements are not identical but should be equal, and therefore, this method is not exact but will yield fairly accurate results.

The dynamometer method of counterbalancing involves making a record of the well load and weighing the static force of the counterbalance at the polished rod. The degree of accuracy depends on the skill used in recording the loads and method of interpretation. To obtain accurate dynamometer results, the card must not be taken until stable pumping conditions are re-established. The time required to achieve this condition is dependent on the well and can range from a few minutes to an hour. When recording the counterbalance force,

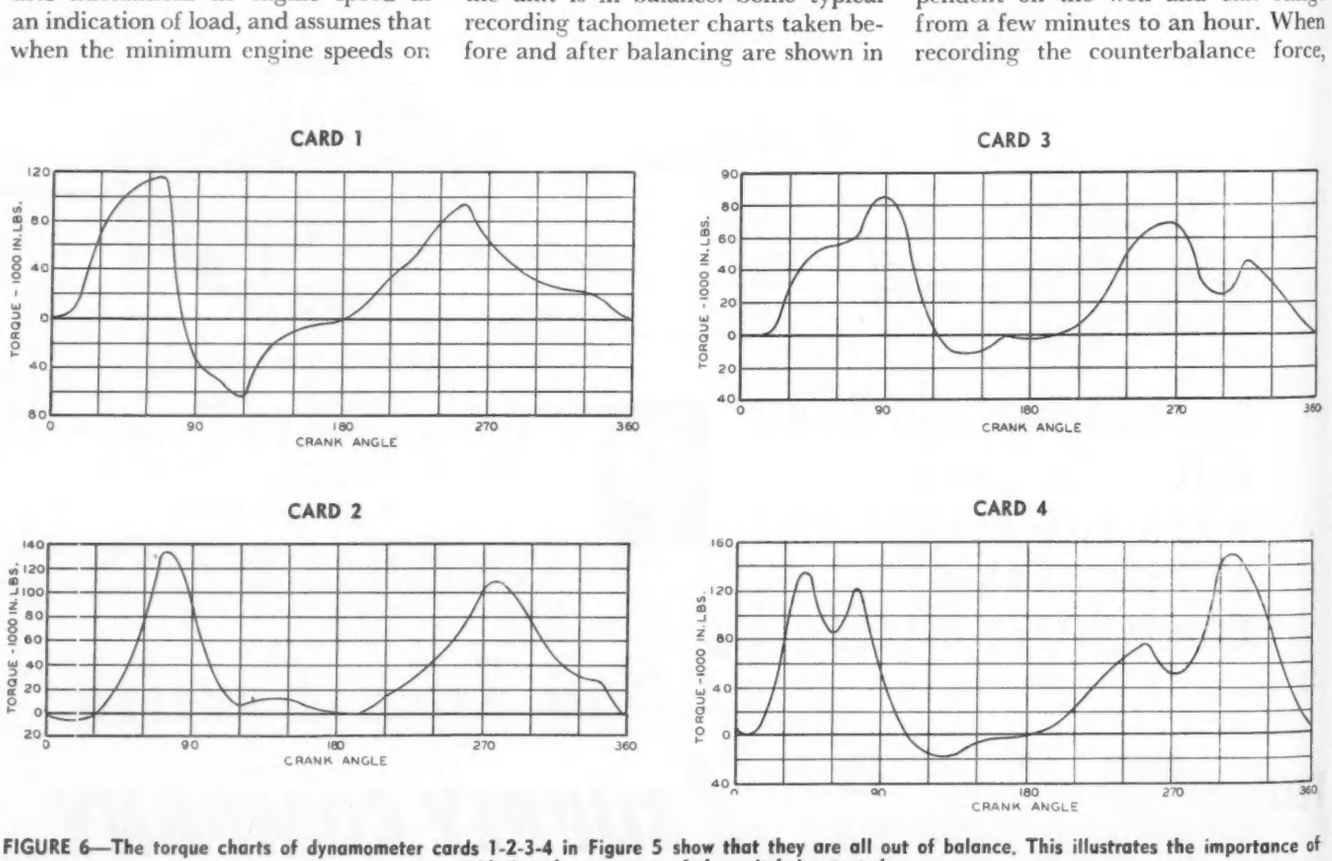

FIGURE 6—The torque charts of dynamometer cards 1-2-3-4 in Figure 5 show that they are all out of balance. This illustrates the importance of considering the geometry of the unit being tested.

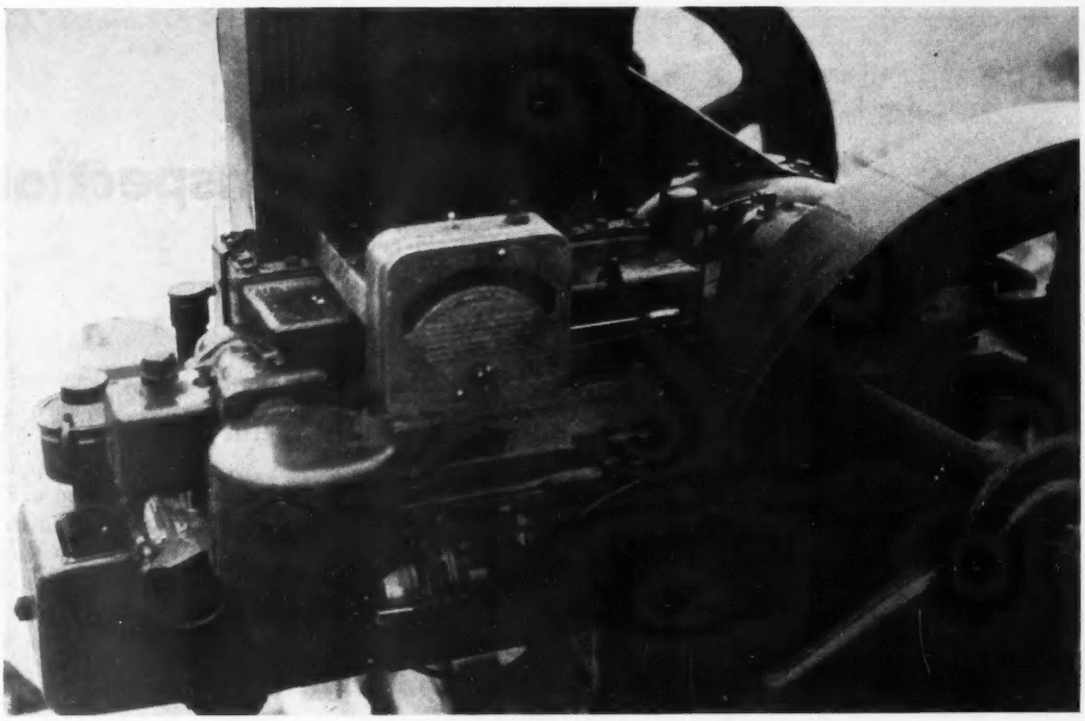

FIGURE 7 — A method of comparing maximum throttle openings on the 2 halves of the stroke cycle is the latest development in counterbalance indicating equipment.

the cranks must be at a known angle from the vertical. The horizontal position is quite convenient.

Interpretation Methods Suggested. Two methods of interpretation have been suggested. One does not involve calculations and assumes that when the counterbalance line, as recorded with the cranks horizontal, is located midway between the minimum and maximum loads, the well is in balance. The second involves calculations which consider the geometric characteristics of the unit. While this method is rather complex, it will be shown that it only will yield dependable results.

When evaluating the dynamometer method, it must be remembered that the purpose of counterbalance is to equalize the torque loads on the two halves of the stroke. Before the well load can produce torque it must be transferred through the pumping unit structure to the reducer. Therefore, the geometric characteristics of the unit must be considered. As the speed of the mechanism is not constant and it has inertia, the reducer loading is further modified by change in the kinetic energy of the system. Due to the complex nature of the mechanism, inertia factors must be neglected in this approach. Also, the effect of friction is neglected. This probably introduces an error in recording the static force of the counterbalance.

The effect of unit geometry on reducer torque loading has been thoroughly investigated[3,4] and the API has established a method for considering its effect. This method uses torque factors. In effect the torque factor is the effective lever arm at any point in the stroke. The torque at any point can be found by multiplying the well load by the torque factor corresponding to that position and subtracting the counterbalance torque for that position. Assuming the counterbalance was weighed in the horizontal position, its torque at any point is expressed by:

$$CBT = CBF \times TFM \times \text{Cos } A$$

where

CBT = Counterbalance torque at angle A

CBF = Measured counterbalance force with cranks horizontal.

TFM = Torque factor with cranks horizontal

A = Angular position from horizontal

Calculate Near Mid-Stroke. To evaluate balance by this method it is necessary to calculate torque for both halves of the stroke cycle near mid-stroke. When these torque values are equal, it is in balance.

Four rather common types of dynamometer cards with the counterbalance line drawn midway between the maximum and minimum loads are shown in Figure 5. According to the simplified dynamometer method, these should be in balance. The results of applying the torque factor method to these cards is shown in Figure 6. In these torque charts it will be noted that all are out of balance. The accuracy of this method is dependent on the geometry of the unit and the shape of the dynamometer card. For some combinations it can be very accurate and for others dangerously in error. Unfortunately, the conditions under which it is reliable cannot be detected by visual inspection.

The latest development in counterbalance indicating equipment is shown in Figure 7. It is applicable to any governor controlled engine. It is actuated by the engine throttle and provides a means for comparing the maximum throttle openings on the two halves of the stroke cycle. If they are equal, the maximum engine power outputs are equal, and the unit is approximately in balance. This instrument is not exact. However, it gives a good visual indication and can be used by any pumper. In addition to indicating the state of balance it contains an adjustable load sensitive switch which will stop the engine if it is over or under speeds. This protects the unit from damage due to rod failures, stuck pumps, and engine over-speeding.

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Ultrasonic Inspection Moves

High frequency sound waves are being used successfully and economically for the location and evaluation of defects in oil field equipment.

By DWIGHT J. EVANS, President
Engineering Test Services, Incorporated
Tulsa

EARLY DETECTION of fatigue cracks in oil field equipment is expensive but necessary. Frequently hazardous failures are to be prevented. This is particularly true when the high pressures and temperatures occurring in production activity today are taken into consideration. It applies not only to equipment already in use but also to new equipment being put into operation. Major defects such as large shrinkage cracks, forging "bursts," laminations, "laps," etc., should be detected, repaired, or the part removed before equipment is put into operation if equipment failure is to be prevented. Some of these defects are evident from a visual inspection. Others are hidden, either internally or extending to a comparatively inaccessible surface such as the I.D. of a drill pipe joint.

Various types of equipment have been developed for non-destructive testing, including X-ray and radiography, magnetic particle methods and other electro-magnetic devices. Ultrasonics, which can be described as mechanical vibrations higher in frequency than audible sound waves, has been added to this list in recent years. It is proving to be a valuable inspection tool, either as a supplement to other types of equipment or as a primary inspection method.

In some applications, such as the detection of cracks deep in the interior of a large forging with dimensions exceeding the range of most X-ray equipment, ultrasonics is the only practical answer. For locating fatigue cracks in shafts or bolts, discontinuities in welds, etc., ultrasonics provides a comparatively inexpensive means of inspection. Disassembly of equipment is usually not necessary, since a thorough inspection can often be made from only one accessible side.

There are applications in which ultrasonic equipment and techniques have not progressed to a point where they offer a practical solution to the inspection problem. Primarily, these applications consist of the detection of corrosion fatigue cracking in the I.D. of used drill pipe and the detection of some types of flaws in new pipe. These defects can usually be located with presently available equipment, but the inspection time required is prohibitive. As experience is gained, techniques improved, and specialized automatic, high speed, scanning and recording equipment developed, ultrasonics will become an even more valuable tool.

Some of the more progressive manufacturers of oil field drilling equipment now have ultrasonic test equipment and use it extensively in their plants. It is used for routine quality control inspection of mud pump parts, such as sprockets and crankshafts. Another manufacturer inspects all shafts on their heavy drilling equipment, and regularly inspects shafts up to 170 inches in length. Others have only occasional need for

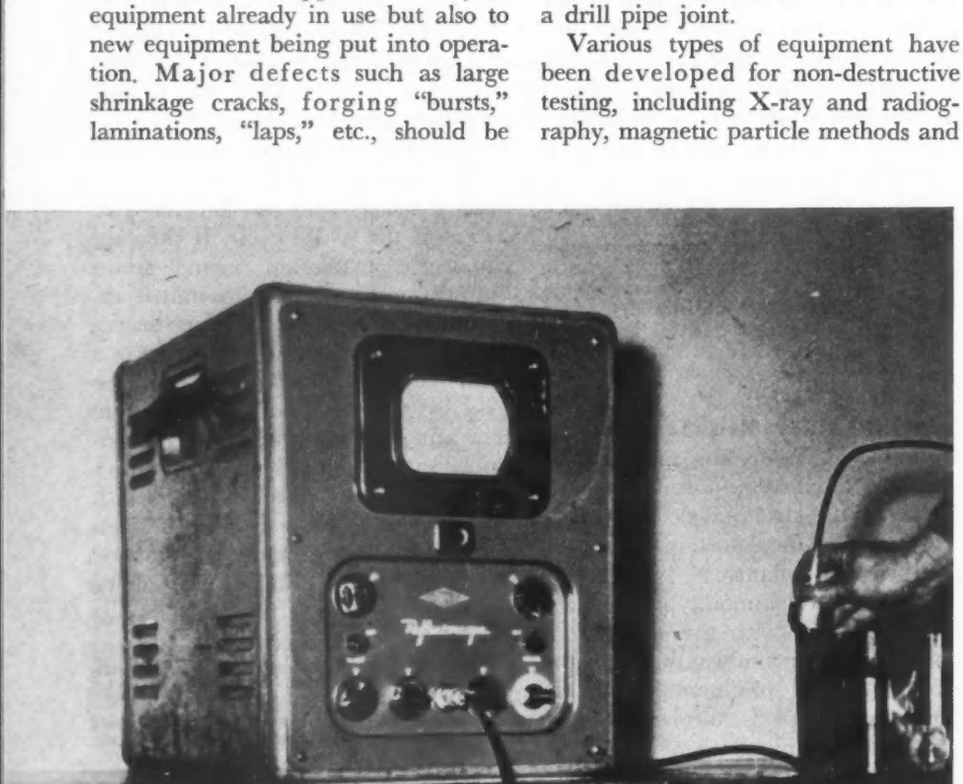

FIGURE 1—There are two general types of ultrasonic inspection equipment now available. This is the versatile 'pulse system'. It offers advantages in applications where accurate location of the defect is desired.

to the Field

this type of testing, and will utilize the services of a test organization specializing in this type of work.

In field testing, where applications may vary, services of specialized test organizations may be preferable since with present equipment, considerable skill and training is required for determination of techniques, interpretation of results, etc. As automation techniques are developed, less training will be required. This is particularly true for applications such as the inspection of a large number of similar pipe joints.

Equipment. The basic component of any ultrasonic system is the "transducer," so called because it transforms electrical waves into mechanical waves or vibrations and vice-versa. It is constructed from quartz, barium titanate or other material with piezo-electric properties. These mechanical vibrations, called ultrasonic because they are usually generated at a frequency above that of audible sound, travel through steel or other homogeneous solids in a manner similar to travel of sound waves through air. They will reflect when they encounter cracks or similar reflecting areas, reflect and refract at interfaces between dissimilar materials and disperse in other discontinuities, as will be described. By using suitable electrical indicating systems, internal cracks and other discontinuities can be indicated visually on a cathode ray tube or recorded on a tape or chart.

There are two general types of ultrasonic inspection equipment now available, the "pulse system" and the "continuous wave" system. The pulsed type is the most versatile. It offers advantages in applications where accurate location of the defect as well as its presence is desired. Newly developed continuous wave equipment is less complicated as well as less expensive and is most useful for some types of rapid testing of a large number of similar parts when only the presence of defects need be known. It is easily adaptable to automatic systems.

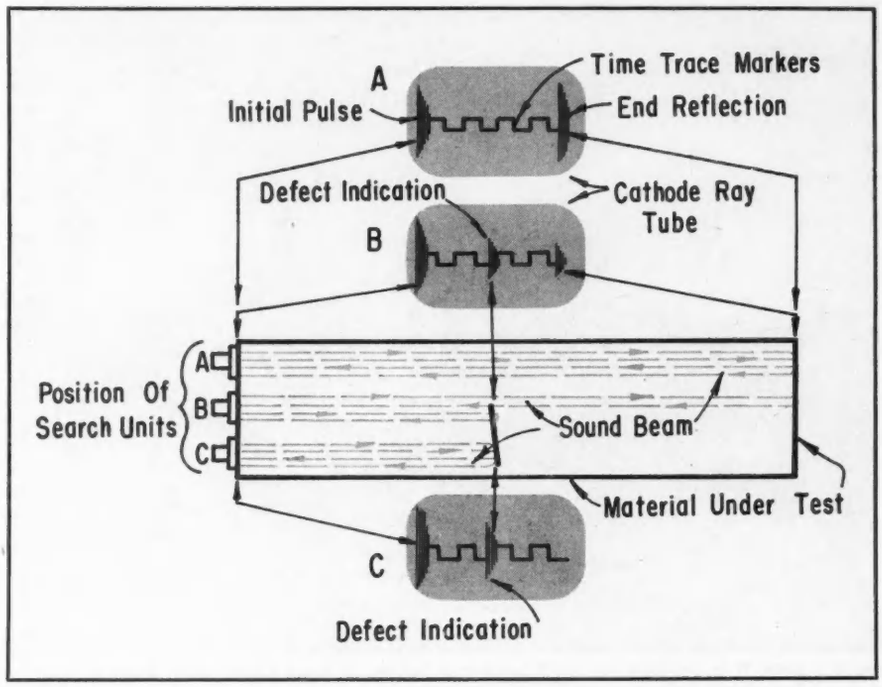

FIGURE 2—Ultrasonic waves projected into the part being tested are reflected and returned to a cathode ray tube for visual presentation. On a 'straight through' test, such as this, the sound beam is analogous to a flashlight beam.

An instrument utilizing the pulse system is shown in Figure 1. To date, it has been used for most of the ultrasonic flaw detection work in the oil industry.

In this instrument, the transmitter "pulses" at regular intervals, the ultrasonic waves are projected into the material under test and are reflected as shown in Figure 2. Since the mechanical vibrations generated by the transducer are microscopic in amplitude, a "coupling medium," such as oil or water, must be used between transducer and test surface for satisfactory transmission through minute "air-gaps." Returning echoes are converted back into electrical waves by

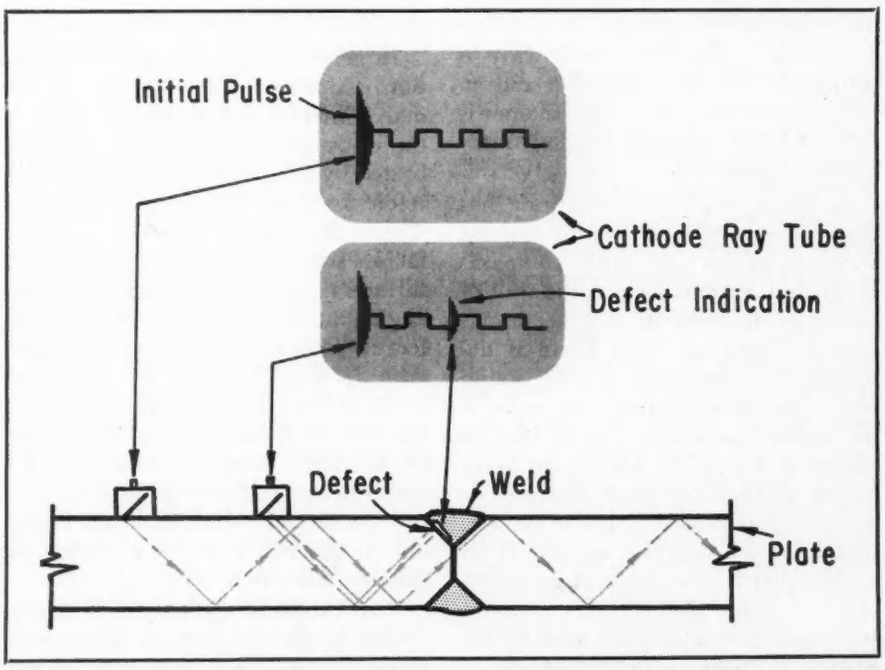

FIGURE 3—In testing thin sections a sound wave is projected into the material at an angle. It reflects off the sides as shown until it dissipates or until it strikes a defect and is reflected back to the search unit.

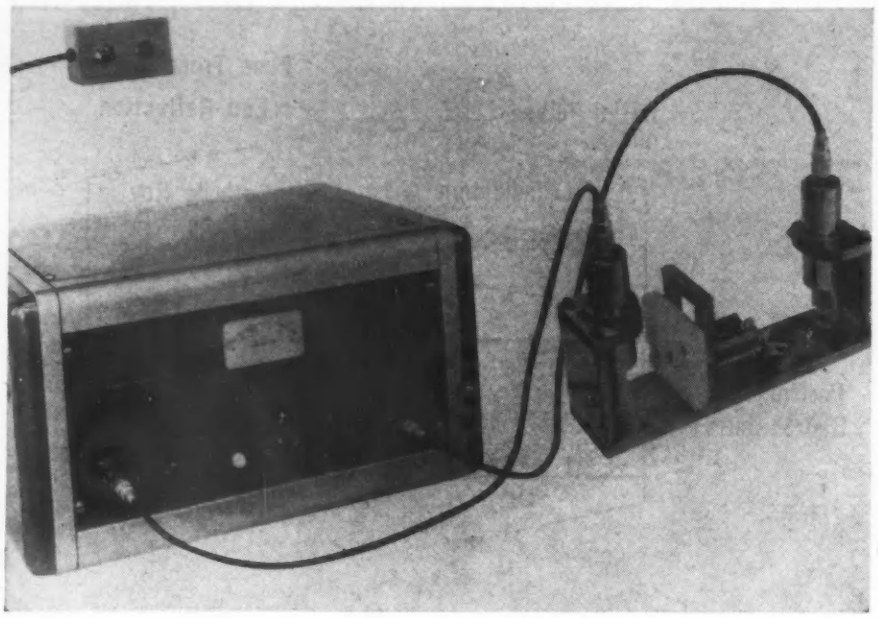

FIGURE 4—The most recent ultrasonic instrument developed for flaw detection is the 'continuous wave' system. It is designed for rapid production testing of large quantities of parts of uniform geometry.

the transducer, amplified by the receiver and presented visually on a cathode ray tube in a manner similar to the presentation on radar equipment. For normal "straight through" testing, the projected sound beam is analogous to that from a flashlight. The beam travels in a direction normal to the surface of the transducer, and reflections are returned along the same path. The wave transmitted is known as a longitudinal wave. Orientation of the defect must be normal or have a component normal to the projected beam in order to produce a reflection. Thus the sound wave is projected into the end of a rod to locate transverse cracks and diametrically to locate longitudinal and transverse components.

A "shear wave" transducer has been developed for testing welded seams in plates and other comparatively thin sections such as the wall of casing or line pipe or in other applications where an angle beam is desirable. This unit projects the sound wave into the material at an angle to the surface on which it is applied, as shown in Figure 3. The sound wave travels through the plate thickness or pipe wall, strikes the opposite surface, reflects at the opposite surface at an angle equal to the angle of incidence and continues through the plate or pipe wall in this manner until it dissipates or strikes a defect which reflects the wave back to the search unit. Such a technique is desirable since, if longitudinal waves are used in thin materials, the "echo" returns before the transmitted pulse is completed and indications are thus confused on the cathode ray tube. In weld testing, the search unit can be placed a short distance from the weld area, and the beam directed into the weld. The search unit must be moved toward and away from the weld in order to survey the entire thickness, as can be seen in Figure 3. In pipe testing, width of the beam is usually sufficient to cover the entire wall thickness.

In general, the amplitude of reflection is determined by the size of the defect intercepting the beam and thus the instrument indication can be calibrated by comparison with a standard reference defect of known dimensions. There are, however, many variable factors such as curvature of the defect surface normal to the beam and the angle that the beam intercepts the defect as compared to a standard reference. Irregularities, twists or angles of a natural crack or its angle with respect to the incident sound beam may be different than the reference and therefore, a crack of the same magnitude as the reference but a less favorable angle will produce a somewhat smaller indication.

Penetration of the ultrasonic waves —that is, the distance the waves will travel in any given material, is dependent upon the frequency of the wave, the elastic constants and grain structure of the material. Penetration on the order of 50 feet can be obtained in some high quality steels, whereas only a few inches may be the limit in low quality cast iron. Usually, the lower frequencies (.5 to 1.0 megacycle) will penetrate a greater distance than the higher frequencies (5.0-10.0 megacycles, or higher) because their longer wave lengths are less affected by grain boundaries and other properties which tend to disperse the wave.

Velocity of sound waves is on the order of 240,000 inches per second in steel.[1] In the Pulse System Instrument of Figure 1, the spacing between distance markers shown on the cathode ray tube is a function of wave velocity. This velocity can be calculated, but for practical purposes the markers are adjusted to represent convenient units of the total distance between the transducer and a known reflection point.

Continuous wave systems for flaw detection differ from the pulse type in that the transmitter operates continuously as does the receiver. Otherwise, behavior of the ultrasonic waves is identical to that of the pulse system. A newly developed instrument in this category is shown in Figure 4. This instrument was designed for the rapid production testing of a large number of parts with uniform geometry. Two transducers and access to both sides of the material under test is required. Usually the material tested is immersed in a liquid which is used as a coupling medium. The continuous waves generated by the instrument and transmitting transducer are passed through the material and received on the opposite side by the receiving transducer. Any discontinuities in the path of the beam will reduce the energy received and this reduction will be proportional to size and/or number of them.

An electrical relay connected to the receiver output is adjusted to reject below a preset limit. Acceptance limits are established by testing parts with known defects. The relay can be used to operate automation accessories, warning lights or bells, etc., without modification.

The presence but not the exact location of discontinuities will be easily and rapidly detected by this equipment. Therefore it is best adapted for high speed detection and rejection of defective parts regardless of the defect

location or testing small areas, such as a weld, where defects, if any, will exist.

Other continuous wave instruments designed specifically for thickness measurement from one side and for laminar flaw detection are widely used in the industry, as mentioned previously. These instruments are highly portable and when used by competent personnel, give accurate and reliable results. Their applications have been described in other literature and will not be discussed here.

Applications. The "Pulse System" Instrument has been applied to a number of field inspection problems during the past several years. The successful applications include inspection of shafts, bolts, etc., for fatigue cracks, inspection of field welds and inspection of drill collars. As mentioned earlier, ultrasonic inspection applications such as the rapid inspection of long lengths of drill pipe, tubing and casing are not feasible with present equipment but can usually be done and will probably be practical with specially designed equipment and associated search units, handling and recording systems.

One example of inspection for fatigue cracking was the examination of connecting rod bolts on a 800 horsepower gas engine. Several bolt failures had been experienced with consequent loss of production and damage to the engines involved. These bolts were 13¼ inches long and 1⅞ inches in diameter. The heads were accessible by removing the crankcase inspection plates and were inspected from this end without removal from the engine. One bolt was used as a test standard and a saw-cut approximately $\frac{5}{32}$ inch deep, and 6 inches from the head end of the bolt was made on one side of the bolt. An oscillogram was made of the cathode ray tube indication, shown in Figure 5. The tests definitely established location and depth of any transverse defects exceeding about .100 inch in depth. Defects of smaller size could not be reliably detected with the equipment and techniques available, particularly in the threaded area.

Permissible size of defects is within the realm of the engine manufacturer. However, judging from results in other tests, the small defects are not critical. In one case, a transverse crack covering approximately 60 per-

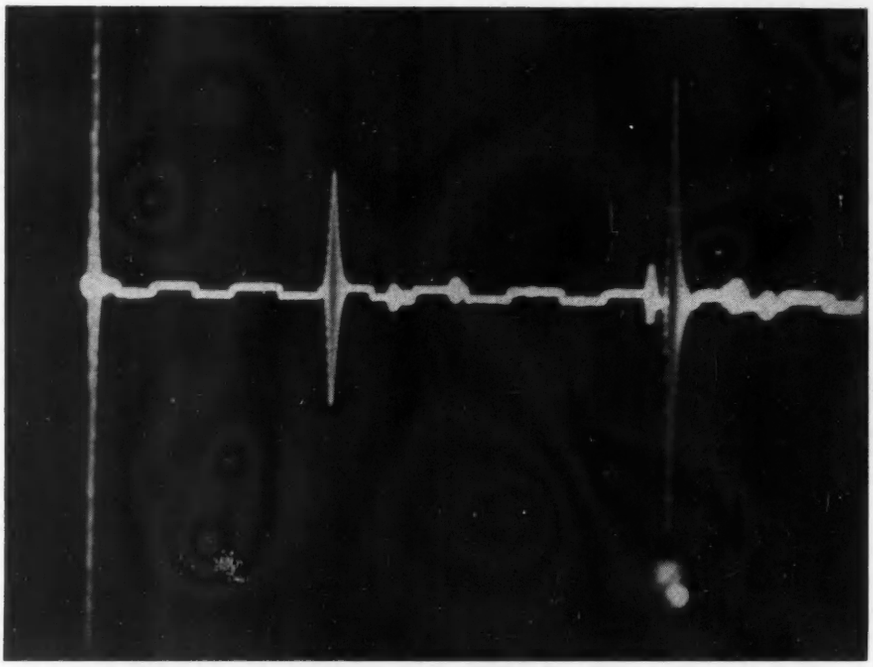

FIGURE 5—This is an actual photograph of the cathode tube face during the inspection of a 13½-inch bolt. Each square wave marker represents one inch. The large vertical line at the left represents the initial pulse. The vertical indication six inches from the left is from a saw cut 5/32-inches deep. At 7½ inches there is a cut .030-inches deep and at 8¾ inches a discontinuity. The indication at 13 inches is from a cotter pin hole and at 13¼ inches the bolt ends. This illustrates graphically the effectiveness of the ultrasonic method of inspection.

cent of the effective cross section of a bolt was discovered. The engine had been in continuous operation with this defective bolt installed. All such bolts on these particular engines are now inspected ultrasonically at each overhaul period.

Crankshafts and "crossheads" in these engines have also been tested. Crankshafts are tested with a "straight beam" and crossheads by both straight and angle beams. These parts can normally be tested in place without dismantling the engine by removing the access plates.

Another important ultrasonic application is the testing of welded seams in field erected storage tanks, shown in Figure 6.[2] Although there are no code requirements for ultrasonic inspection of welded seams in new pressure vessels, tanks, etc., some users specify such tests. One major oil company regularly inspects pressure vessels fabricated for them at the vendor's plant and particularly those vessels manufactured from materials with a tendency to cracking. Comparatively rapid preliminary ultrasonic surveys are made and suspicious areas later radiographed to meet code requirements. For example, in an inspection now in progress, about 40 feet of welded seam is inspected per hour with presently available equipment. Plates are 3 inches thick. Uniform sensitivity standards for these inspections, determined by the various regulatory bodies such as has already been done in the aircraft industry, are needed and are now under consideration.

A field survey of main seam welds in a number of large spherical storage tanks (5,000 to 10,000 barrels capacity) conducted in 1953 disclosed a serious defect and led to extensive use of ultrasonic testing by the operator involved. About 190 to 240 feet of main seam welds in each tank was inspected. Very little information as to sensitivity standards, previous work, etc., was available and it was decided that the first tank be inspected in conjunction with radiography, trepan plugs, and "arcair gouging." As a basis for reasonable correlation of data, the instrument sensitivity was set for a 1½-inch "peak to peak" indication from a vertical $\frac{5}{16}$-inch "lack of penetration" defect in a ⅞-inch thick carbon steel test plate. Fairly good correlation was obtained and the decision to test the remaining vessels by ultrasonics alone was made, particularly since they could be tested without removal from service.

The serious defect mentioned above was found in one of the latter tanks. It consisted of a 1½-inch "lack of

FIGURE 6—Another important production application of ultrasonics is the testing of welded seams in field erected storage tanks. Fairly rapid preliminary ultrasonic surveys are made and suspicious areas radiographed later to meet any code requirements.

fusion" crack extending 3 feet, 6 inches and a ¼-inch to ½-inch lack of fusion crack extending intermittently for 5 feet, all in the lower circumferential seam of one of the tanks. Plate thickness was $^{11}/_{16}$ of an inch. The tank was removed from service and the cracks verified by trepan plugs, arcair gouging and radiograph. They were at an angle of about 60 degrees to the surface and were, therefore, not outstanding in the radiographs until exposures were made parallel to the cracks. Fortunately the "lack of fusion" was intermittent to a certain extent, one reason that such extensive defects did not result in failure of the vessel.

Numerous other minor defects, including ⅛-inch to $^{3}/_{16}$-inch cracks, slag inclusions, etc., were found; some of which would be rather difficult to show with normal radiographic techniques. Many of them were not considered serious and no supplementary examinations were made. Of the ones examined by other methods, only a few could not be verified by trepan plugs or radiographs. This may have been due to inaccurate re-location, weld bead shadows, unfavorable angles of radiograph exposures or the fact that ultrasonics are affected by discontinuities normally not considered defects. For example, a reflection will occur from a particularly uniform weld "bead" or a definite and abrupt grain structure change at the interface between parent and weld metal. Weld bead reflections can usually be identified by careful measurement. Although there is much to be learned in field weld testing, it may be concluded that with present equipment, the general quality of seam welds can be determined rapidly and comparatively inexpensively by exclusive ultrasonic inspection. If poor quality weld is indicated, it should be investigated further by radiographic inspection and/or sectioning. As more experience is gained, industry wide standards are set and data from other investigators correlated, ultrasonics will become an even more valuable tool.

Conclusions. 1. Present ultrasonic test equipment is being used successfully and economically for location and evaluation of defects in oil field equipment such as drill collars, shafts and bolts, etc.

2. It is a valuable tool for the evaluation of welded seams in storage tanks, pressure vessels and other similar structures. Industry wide experience, correlation of data and standardization is needed for maximum utilization in this field.

3. Cost of ultrasonic inspection compares very favorably with other methods since equipment can usually be inspected without dismantling, or in the case of piping, storage tanks, etc., removing them from service.

4. Ultrasonic inspection is a valuable supplement to other types of nondestructive testing and in some cases, can reveal defects not ordinarily detected with other methods.

5. Low cost, simplified and easily portable equipment is desirable and its development for miscellaneous oil field applications is contemplated. More elaborate automatic systems including provision for rapid scanning and recording are required for practical production testing of long strings of drill piping, casing, etc. Such systems are also desirable for rapid production testing of welded seams in pressure vessels, electric weld pipe, etc.

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Unsteady State Flow in Gas Reservoirs

A detailed procedure by which flow after flow problems, such as normally occur in field production or in back pressure testing of gas wells, may be solved using the Van Everdingen and Hurst solutions for unsteady state flow.

By DAVID CORNELL
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SEVERAL TYPES OF natural gas reservoir engineering calculations can be made by use of the solutions of Van Everdingen and Hurst[4] for unsteady state flow. Draw down pressures after a single flow period can be calculated as has been shown previously.[3] A number of other types of flow problems may also be solved with these solutions. Among these problems is the flow after flow, or multiple transient, case. The back pressure test for natural gas wells is ordinarily of this type of problem with four successive flow rates. In general, any case of gas production in which the flow rate is changed from time to time is a problem of this kind.

Nature of Flow After Flow Production. When a shut in gas well is opened to flow at a constant rate, a pressure gradient is established in the reservoir. The pressure draw down will be greatest at the well bore, and the pressure will increase with distance away from the well until the reservoir pressure is reached. This pressure profile gradually moves out into the reservoir as time goes by until the extremity of the reservoir is reached.

If the flow rate is changed at any time, a new pressure gradient is produced and moves out into the reservoir as did the first. However, the first transient continues to move outward as before and can still be identified. Similarly, the new transient due to the change in flow rate retains its individual identity and can be described. The resultant pressure gradient is the sum of these two transients taken on a proper rate and time basis.

Dimensionless Groups. Before taking up flow after flow calculations, the dimensionless groups used in pressure draw down or build up computations will be reviewed. The dimensionless time group Θ is given by equation 1.

$$\Theta = \frac{4.39 \times 10^{-4} \, K \, \bar{p} \, \theta}{\mu \, \phi \, r_w^2} \qquad (1)$$

The dimensionless flow rate group, m, which determines the slope of the pressure gradient in the reservoir, is given by equation 2.

$$m = \frac{1{,}424 \, \mu \, z \, T \, Q}{h \, K \, p_f^2} \qquad (2)$$

The pressure ratio is p/p_f and the dimensionless draw down number is P_Θ. Values of P_Θ are obtained from the dimensionless time group Θ as shown previously.[3]

Flow After Flow Equations. The first flow rate in a series of flows is designated as Q_1, the second as Q_2, and so on. The time at the end of the first flow rate is designated as θ_1. The total time for the first and the second flow rates is θ_2. Similarly, the total time for the first three flow rates is θ_3, and so on. The values of the dimensionless flow rates m_1, m_2, m_3, etc. correspond to the proper Q_1, Q_2, Q_3, etc., values and the dimensionless time values Θ_1, Θ_2, Θ_3, etc., are those calculated from θ_1, θ_2, θ_3, etc.

When setting up the equations for flow after flow production, the relationship for the draw down pressure due to each change in flow rate must be established. Then, the draw downs are added together to obtain the net or over-all draw down in pressure. This last step is a simple addition; however, it is called "superposition" because of the mathematical superposition theorem that permits such addition.

The draw down in pressure for the first dimensionless flow rate m_1 at dimensionless time Θ_1 has been established[3] as given in equation 3.

$$p_f - p_s = \frac{m_1 \, p_f^2 \, P_{\Theta_1}}{2 \, \bar{p}} \qquad (3)$$

If the same dimensionless flow rate m_1 is continued until dimensionless time Θ_2, the draw down in pressure at the well bore is given by equation 4.

$$p_f - p_s = \frac{m_1 \, p_f^2 \, P_{\Theta_2}}{2 \, \bar{p}} \qquad (4)$$

Now the case in which the gas well is allowed to flow at rate Q_1 for the time θ_1 and then the rate is changed

to Q_2 and held at that value until the total elapsed time from the initial opening of the well is θ_2 will be considered. The pressure draw down due to Q_1 will be exactly that given by equation 4, because the initial transient is visualized as having continued right up until time θ_2.

During the time from θ_1 to θ_2 a flow rate increase amounting to $Q_2 - Q_1$ occurred. This flow rate increase lasted for the time $\theta_2 - \theta_1$. The pressure draw down caused by the increase in flow rate is given by equation 5.

$$p_f - p_s = \frac{(m_2 - m_1)\ p_f^2\ P_{(\theta_2 - \theta_1)}}{2\ \bar{p}} \qquad (5)$$

Now that the draw downs in pressure for the initial flow rate and the increase in flow rate have been found, the over-all draw down in pressure may be obtained by adding the two separate draw downs as in equation 6.

$$p_f - p_s = \frac{m_1\ p_f^2\ P_{\theta_1}}{2\ \bar{p}} - \frac{(m_2 - m_1)\ p_f^2\ P_{(\theta_2 - \theta_1)}}{2\ \bar{p}} \qquad (6)$$

Equation 6 may be used to calculate the flowing bottom hole pressure after two successive flow rates have been maintained.

Illustrative Problem. A shut in natural gas well is opened and produced at a rate of 3000 Mcf/D for 4.0 hours and at that time the rate is increased to 6000 Mcf/D and maintained at the higher value for 4.0 hours longer. The gas properties and formation characteristics are as follows:

Formation temperature 180° F.
Shut in formation pressure 2300 psia
z 0.89
u 0.0168 centipoise
h 12 feet
K 28 millidarcys
r_w 0.5 feet
ϕ 15 percent porosity

The pressure at the well bore at the end of the 8.0 hours is to be calculated.

Solution

Estimate $\bar{p}$ to be 2200 psia.

$$\theta_1 = \frac{4.39 \times 10^{-6} \times 28 \times 2200 \times 4 \times 60}{0.0168 \times 0.15 \times 0.25} = 103{,}000$$

$$\theta_2 = \frac{4.39 \times 10^{-6} \times 28 \times 2200 \times 8 \times 60}{0.0168 \times 0.15 \times 0.25} = 206{,}000$$

$$P_{\theta_2} = \tfrac{1}{2}[2.3026 \log_{10} 206{,}000 + 0.80907] = 6.5224$$

$$P_{(\theta_2 - \theta_1)} = \tfrac{1}{2}[2.3026 \log_{10} (206{,}000 - 103{,}000) + 0.80907] = 6.1758$$

$$m_1 = \frac{1{,}424 \times 0.0168 \times 0.89 \times 640 \times 3000}{12 \times 28 \times 2300^2} = 0.0230$$

$$m_2 = \frac{1{,}424 \times 0.0168 \times 0.89 \times 640 \times 6000}{12 \times 28 \times 2300^2} = 0.0460$$

$$p_f - p_s = \frac{0.0230 \times 2300^2 \times 6.5224}{2 \times 2200} + \frac{(0.0460 - 0.0230) \times 2300^2 \times 6.1758}{2 \times 2200} = 351 \text{ psia}$$

$$p_s = 2300 - 351 = \underline{1949 \text{ psia Answer}}$$

A slightly lower value of $\bar{p}$ might have been chosen, but the correction would not be great.

Several Flow After Flow Production Periods. The same procedure for two successive flow after flow production periods will now be extended to several flow after flow production rates. The equation for three successive flow rates is given as equation 7.

$$p_f - p_s = \frac{m_1\ p_f^2\ P_{\theta_3}}{2\ \bar{p}} + \frac{(m_2 - m_1)\ p_f^2\ P_{(\theta_3 - \theta_1)}}{2\ \bar{p}} + \frac{(m_3 - m_2)\ p_f\ r_{(\theta_3 - \theta_1)}}{2\ \bar{p}} \qquad (7)$$

The equations for additional changes in flow rate can be readily obtained by extension of equations 6 and 7. The use of equation 7 in numerical problems is exactly the same as the procedure given for equation 6 except that there are a few more steps in the calculation.

The illustrative problem given above assumed that the pressure gradients had not reached the extremity of the reservoir or producing area belonging to the well. If such is the case, the same procedure would be followed; however, tables of P_θ values for finite reservoirs given by Van Everdingen and Hurst would be used. An additional assumption has been made that an average reservoir pressure $\bar{p}$ can be used as a constant pressure in the derivation of the basic equations.

The illustrative problem discussed in this paper can be solved in an entirely different way using charts previously presented (1, 2) giving the same answers.

Conclusions. The procedure for solving successive flow rate, or flow after flow, production problems in natural gas reservoirs by use of the Van Everdingen and Hurst solutions has been presented and illustrated by means of a typical problem. Such calculations are of interest in natural gas reservoir engineering problems involving the conventional back pressure test and typical field production scheduling.

NOMENCLATURE

m_1 dimensionless flow rate for first flow Q_1
m_2 dimensionless flow rate for second flow Q_2
$m = \dfrac{1424\ \mu\ z\ T\ Q}{h\ K\ p_f^2}$
μ viscosity of the reservoir gas, centipoises
z compressibility factor
T absolute reservoir temperature, ° Rankine
Q flow rate, Mcf/D at 14.7 psia and 60° F.
h formation thickness, feet
K permeability, md
p_f shut in formation pressure, psia
$\bar{p}$ average reservoir pressure, psia
p_s flowing bottom hole pressure, psia
P_{θ_1} dimensionless draw down number evaluated at dimensionless time 1
P_{θ_2} dimensionless draw down number evaluated at dimensionless time 2
θ dimensionless time $= \dfrac{4.39 \times 10^{-6}\ K\ \bar{p}}{\mu\ \phi\ r_w^2}$
r_w well bore radius, feet
θ time, minutes
θ_1 time at the end of the first flow rate, minutes
θ_2 time elapsed from the opening of the well to the end of the second flow rate, minutes

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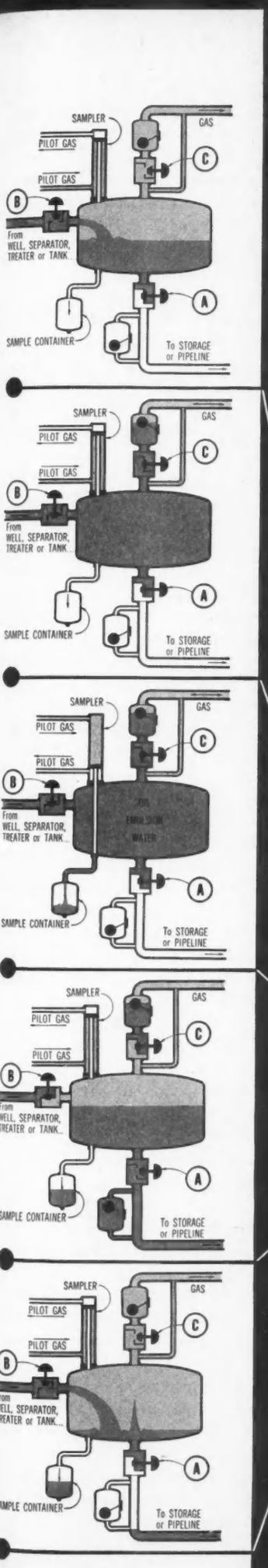

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- **CORE BARREL SAMPLING OF LIQUID** — Valves **A**, **B** and **C** are closed. Sample tube is driven vertically through the liquid, assuring a representative, proportional sample of the entire content as it exists in the vessel. Sample is discharged to a container for future analysis. Sampler is retracted.
- **DISCHARGING AND RECORDING** — Valve **A** now opens permitting vessel to empty the positive volume. The cycle counter is actuated. Valves **B** and **C** are still closed.
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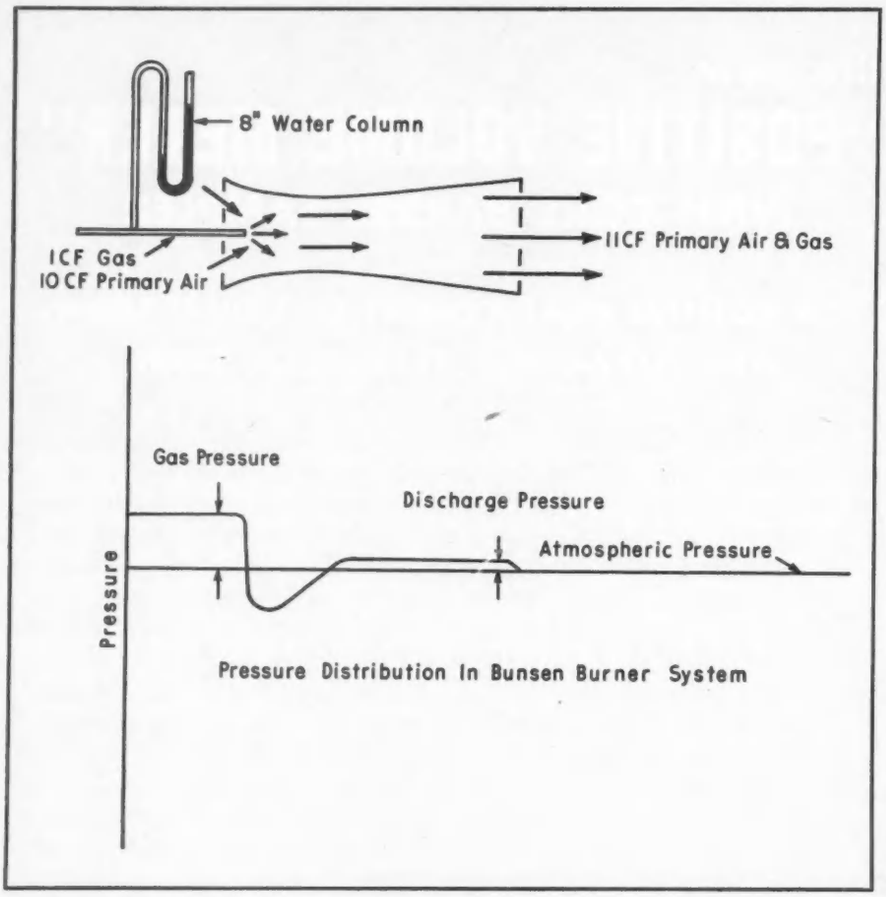

FIGURE 1—Conditions of flow in a Bunsen burner demonstrate quite well the theory of a gas jet compressor.

Gas Jet Compressors Are Arousing Interest

Producers are taking a closer look at this ingenious device as a means of putting low pressure gas into intermediate pressure lines.

By FRANK H. DOTTERWEICH and C. V. MOONEY
Division of Engineering, Texas College of Arts and Industries
Kingsville, Texas

THE GAS JET compressor has proved itself a valuable unit to gas producers with a source of high pressure gas and a quantity of low pressure gas. Now the low pressure gas can be placed in an intermediate pressure line without the costs associated with a conventional compressor.

The gas jet compressor is a simple device with no moving parts which enables low-pressure gas to be entrained into a stream of high-pressure gas. It is a new application in the natural gas industry, yet it employs basic principles of gas entrainment practiced since the discovery of the Bunsen burner. In these jet entrainment operations, a gas under pressure is allowed to expand with a resulting increase in velocity and, as it passes through a restriction gas or fluid at a low pressure, is entrained. The velocity of the resulting mixture is reduced and the pressure increased to that above the gas entrained.

Development and use of this equipment has been increasing rapidly. This trend will continue because of many installations where high-pressure natural gas is available which must be reduced in pressure principally along delivery points in natural gas transmission line operations.

The uses to which the gas jet compressor is being put, to a great extent are where pressure of the motive and suction gas do not vary. Under these conditions, the gas jet may be designed, built and placed in satisfactory operation. There is a great opportunity for the application of gas jet compressors in natural gas practices, especially on dually-completed gas wells where both high-pressure and low-pressure gas are available, and where there is an intermediate pipe line pressure. Although the gas jet compressor is relatively inexpensive, a large part of its costs is for engineering design work. Likewise, the gas jet compressors presently available must operate very close to design conditions since any change in operating pressure seriously impairs their performance. Therefore, it appears that a gas jet compressor so designed to give flexible operating characteristics by adjustment in the field would do much to encourage the use of such equipment. The development of such a gas jet compressor to operate satisfactorily in the field would make additional quantities of low-pressure gas available with a large saving in the capital expenditure.

Applications. The gas jet compressor may be used in any number of applications where two gas streams (one at high-pressure, the other at low-pressure) are to be combined to form a gas mixture at some intermediate pressure. Warner[3] has discussed the design, performance and application of the gas jet in gas mixing. Fletcher[2] notes various gas jet applications including one in which high-pressure natural gas from a transmission line was used to boost manufactured gas to distribution line pressures. In this

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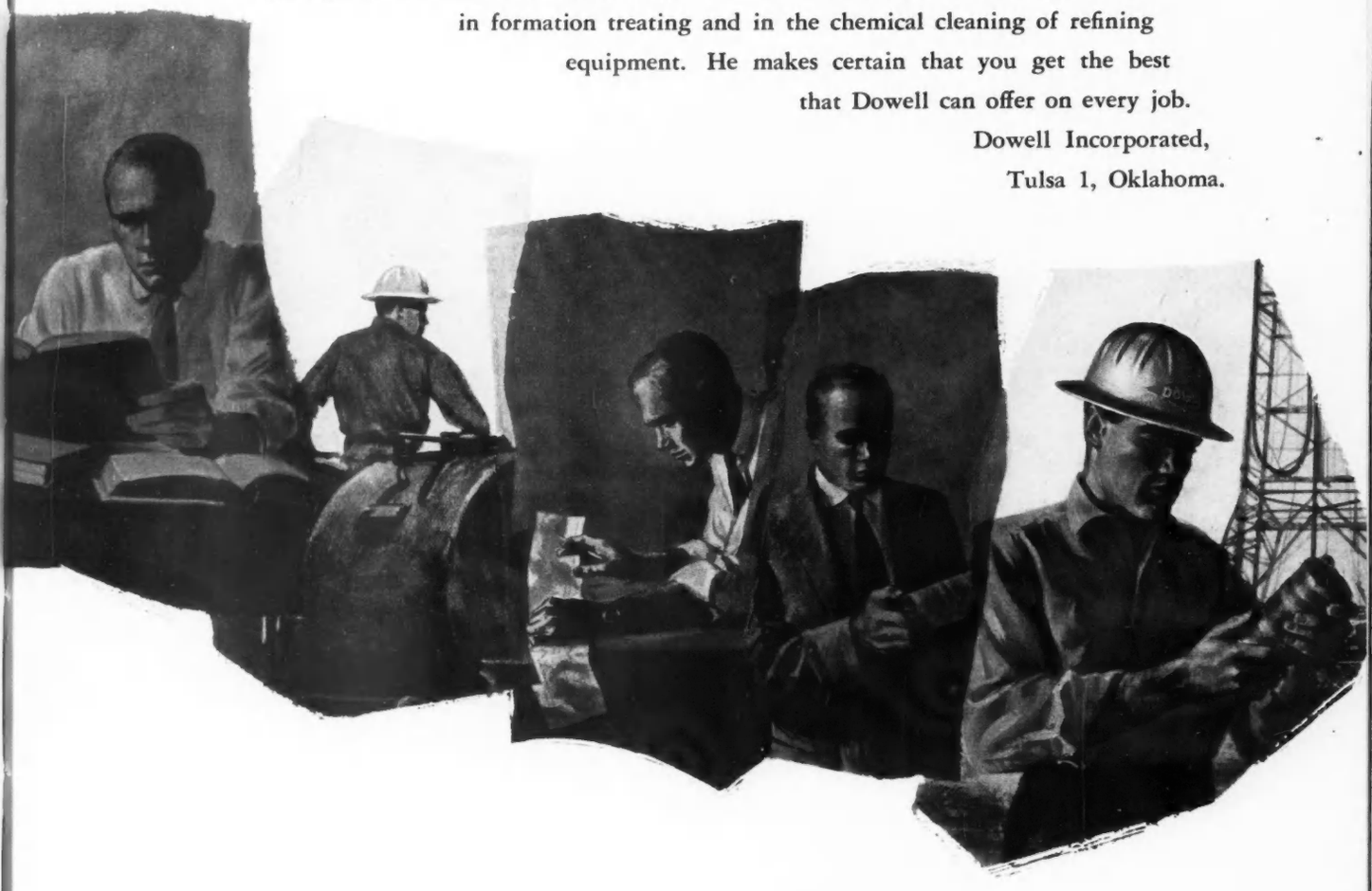

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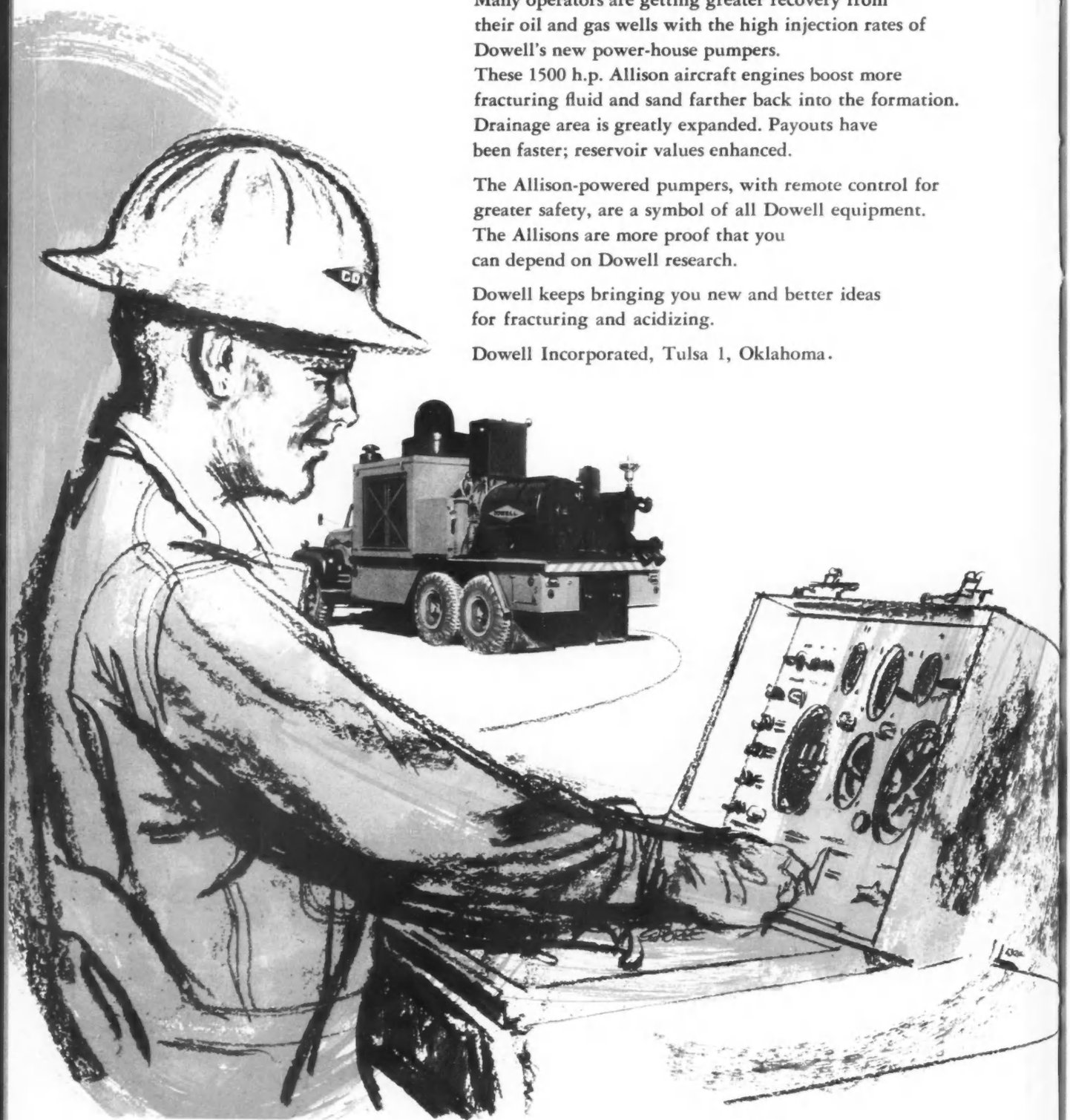

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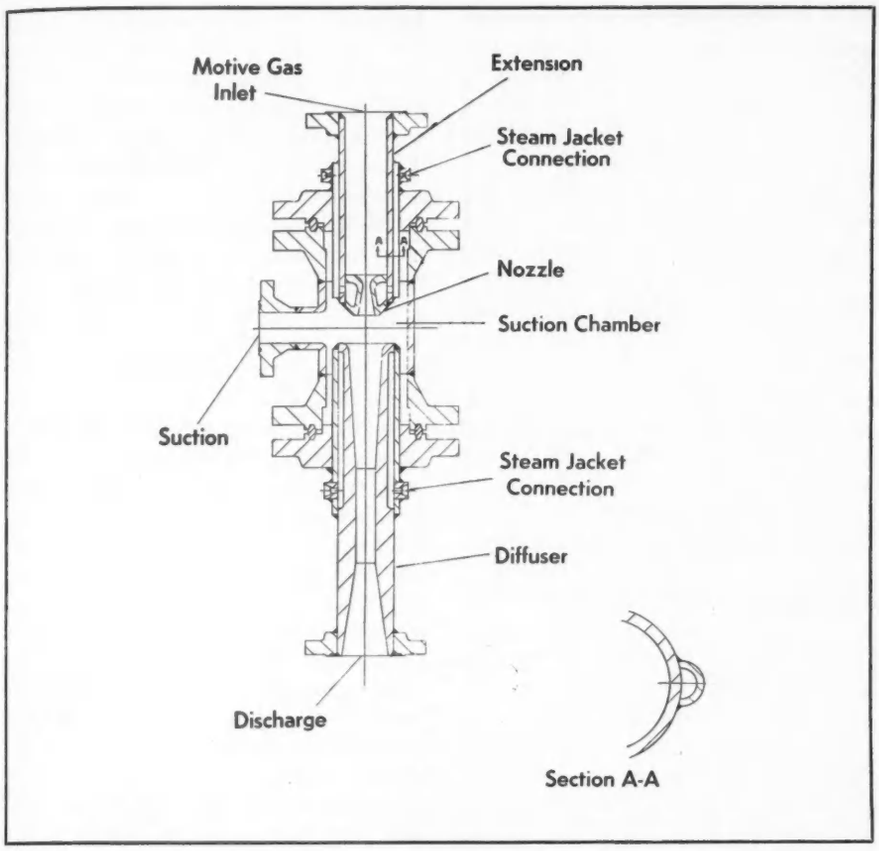
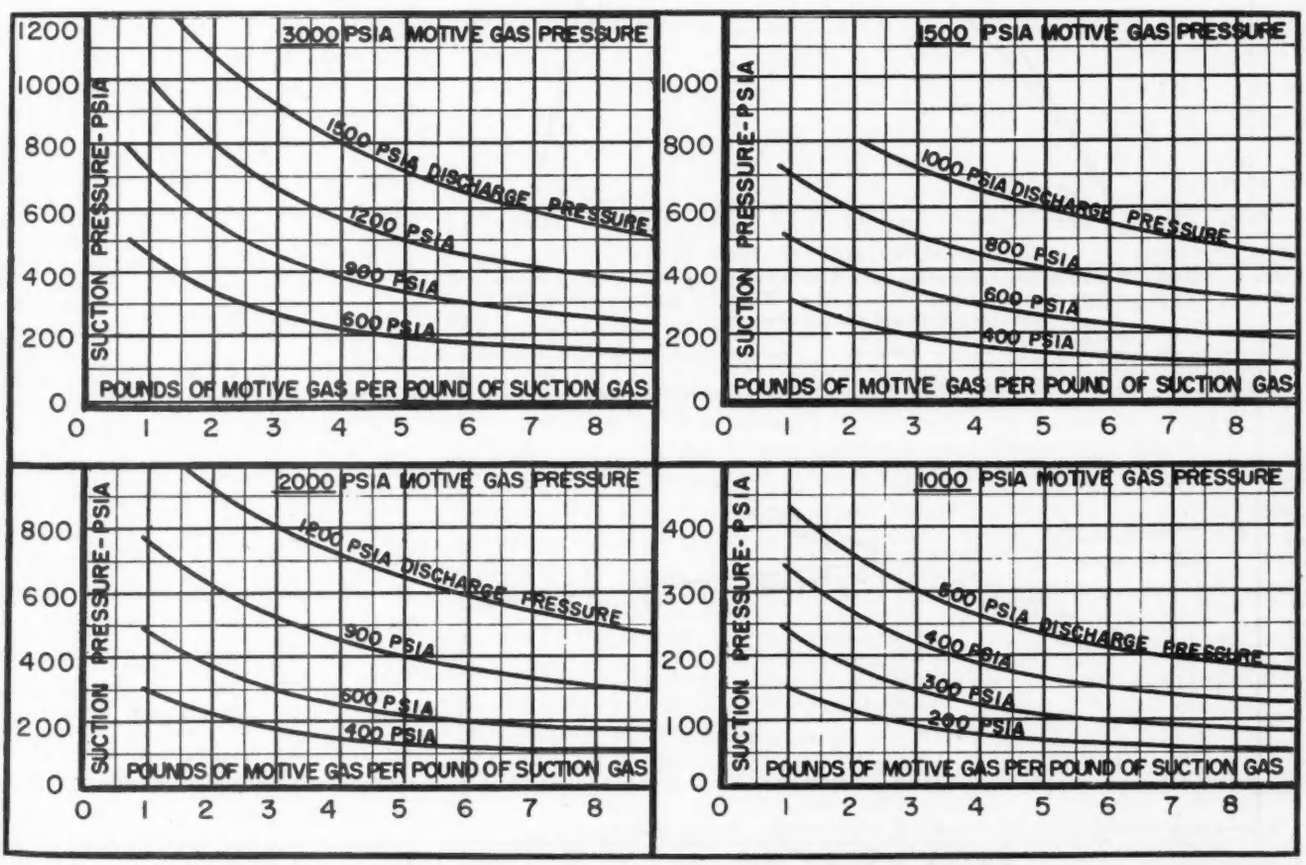


FIGURE 2—Gas jet compressor shown in cross-section is relatively simple. It consists of four main parts: a suction chamber, a nozzle extension, a nozzle and a diffuser.

operation, a large utility company effected a great saving in capital expenditure by replacing obsolete motor-driven centrifugal compressors with gas jet compressors.

Theory. The theory of the gas jet compressor may be better explained by observing the conditions of flow existing in a low-pressure Bunsen-type burner system. Such a system is shown in Figure 1. One cubic foot of natural gas could entrain 10 cubic feet of air required for its complete combustion, provided the pressure at the orifice was about 8 inches of water pressure and orifice size and burner proportions were designed correctly.

In this case, the design was based on the assumption that for a given burner, the momentum (product of mass and velocity) of the gas as it leaves the orifice, bears a sufficiently constant ratio to the momentum of the mixture of gas and primary air as it passes any definite cross section of the burner, to permit use of such a constant in most design problems. A theoretical demonstration of this re-



Requirements of high pressure motive gas to compress a gas of the same density to several discharge pressures shown above are qualitative and merely serve to indicate the possibility of a certain project. Data developed by Fletcher.[3]

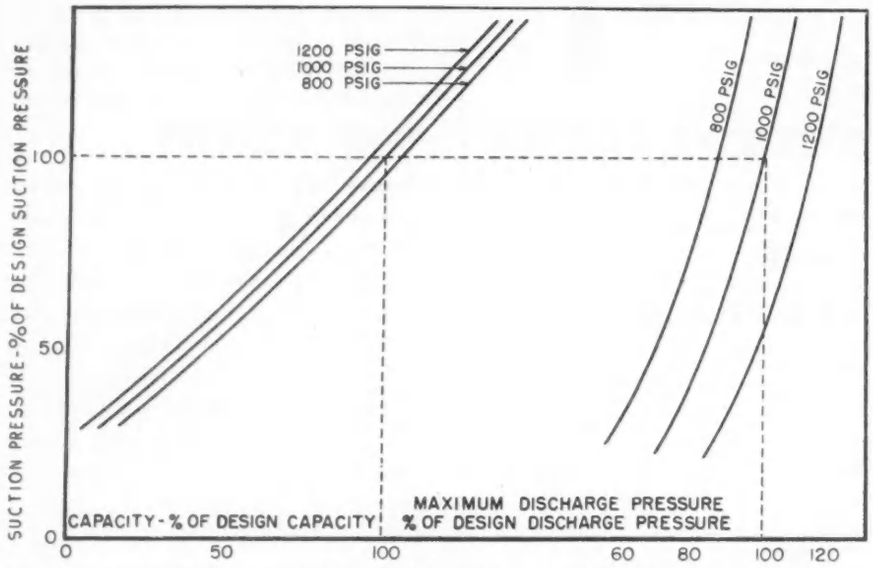


FIGURE 4—Performance curves developed by Fletcher[1] show characteristics that may be expected in the operation of gas jet compressors.

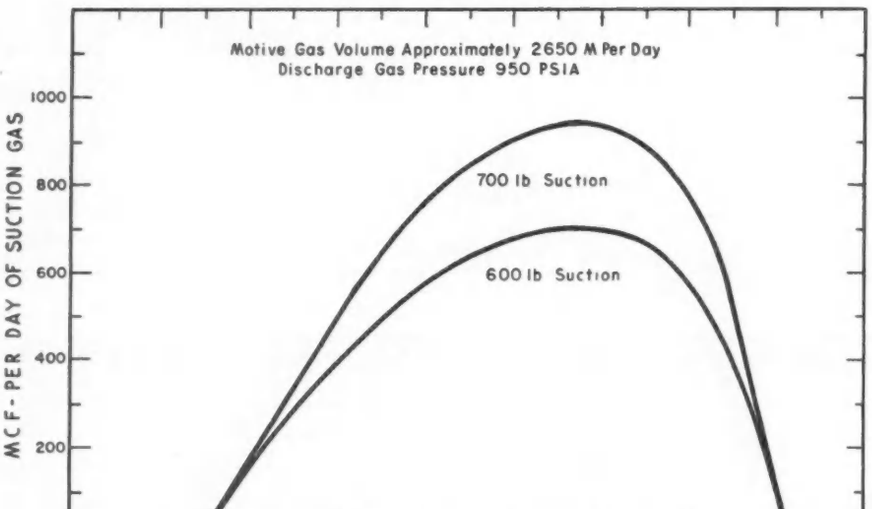


FIGURE 5—Volume of suction gas compressed to 950 psia by varying motive gas pressure and maintaining suction pressure constant. Upper curve is for a 700-pound suction pressure; the lower curve for 600-pound suction pressure.

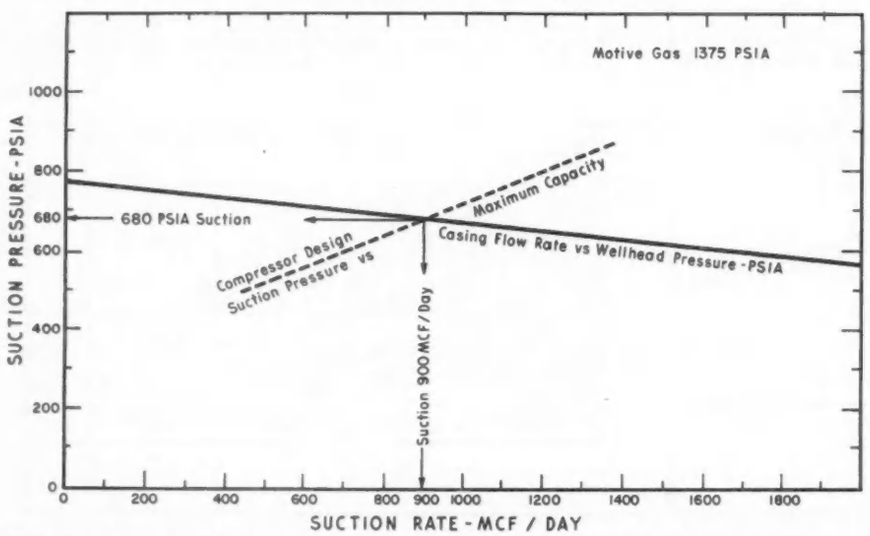


FIGURE 6—Quantity of suction gas that can be compressed to 950 psia by varying the suction pressure and maintaining motive gas pressure constant at 1375 psia.

lationship involves assumptions which are not justified except by the result of the experiments themselves. Therefore, the rule is entirely empirical but very helpful in design operations. These theoretical assumptions, to a certain extent, are confirmed when the unit is placed under test. Figure 1 also indicates the pressure distribution throughout the system from the motive pressurized natural gas, the suction air and the discharge mixture above the normal atmospheric pressure.

In the so-called gas jet compressor shown in Figure 2, higher pressures and velocities are used. The high-pressure gas expands through a converging-diverging nozzle with an accompanying decrease in pressure and temperature and with little increase in entropy of the gas. As a result, velocities of 2000 to 3500 feet per second may be obtained. The entrainment properties of this high velocity jet pull low-pressure gas into the jet stream. The resulting mixture of high-velocity jet gas and large volumes of low-pressure entrained gas enters the diffuser where the kinetic energy of the gas mixture is transformed into pressure. It can be seen that the operation of a gas jet compressor is highly dependent upon design and finish of its internal parts.

Design and operation. In the design of gas jet compressors, it is helpful to know about how much high-pressure gas is required to compress gas of the same density to various discharge pressures. Fletcher[1] has given this subject of gas jet compressor design concentrated study and has developed the curves shown in Figure 3. These curves do not give the exact value, but merely serve to indicate the possibility of a certain project.

Performance curves have also been studied by Fletcher and Figure 4 notes characteristic curves that may be expected in the operation of gas jet compressors. One set of curves is obtained by holding the motive (high-pressure gas) pressure constant varying the suction gas flow and noting the suction pressure. From these data, the percent of design capacity versus the percent of design suction pressure may be plotted. Should the motive and suction pressures be maintained constant, and the discharge line

gradually closed with the discharge pressure building up, the jet will maintain constant suction pressure until a critical discharge pressure is reached. At this point, the suction pressure will increase. The discharge pressure at which this occurs has been defined[1] as the "maximum back pressure."

By determining this maximum back pressure at several suction pressures, a curve may be developed to show the relationship of maximum discharge pressure, and as percent of design suction pressure. These curves indicate that for a gas jet to perform as desired, the motive pressure must not fall below design pressure unless the discharge pressure is also lowered. Also, the discharged pressure should not be increased above the design pressure unless the motive pressure is increased.

Formulae that are helpful in the design of gas jet compressors have been developed and are noted in Appendix I, Section 1. Calculations for the design of a gas jet compressor to fit a certain field requirement are given in Appendix I, Section 2.

Efficiency low. These calculations indicate that the gas jet compressor has an over-all efficiency of about 20 percent. This low efficiency limits the number of conditions in which it can be used. An ideal situation for its use is where high-pressure gas is available that must be reduced in pressure before it can be transported or processed. This high pressure energy, heretofore dissipated and wasted, is available through a gas jet compressor to boost low-pressure gas to pipe line pressure. It is this application that has been studied in the laboratory and by field installation.

No servicing required. In the operation of a gas jet compressor, little or no servicing or maintenance is required for the inexpensive unit. However, it must be accessible for inspection.

Hydrate problem. As the high-pressure gas expands in the nozzle (Figure 2) with ensuing high velocity, low temperatures are encountered. The temperature attained at the tip of the nozzle may be so low that hydrate formation will result, and the build-up of solid particles may interfere with operation. This hydrate formation may be eliminated by heating the motive gas, which is an expensive and rather difficult procedure. Hydrate formation at the nozzle will interfere with jet operation only when it adheres to the nozzle. Therefore, should the nozzle be heated sufficiently to prevent the solids from adhering and building up, satisfactory operation can be assured. The nozzle and diffuser can be heated electrically or with small quantities of steam applied to jackets as noted in Figure 2.

Field studies. Studies on gas jet compressors were limited to theoretical calculations and a study of laboratory units until a gas jet compressor was made available for field study by the courtesy of James E. Pew of Sun Oil Company. This compressor has been used in a cooperative research program with engineers of The Chicago Corporation on dually-completed gas wells in the Stratton Field of Texas.

The jet compressor as received from the Sun Oil Company had been designed for operating conditions other than those encountered on the dually-completed gas well available for test in the Chicago Corporation production field. It was redesigned as noted in the appendix to conform to these new conditions.

The results of one series of tests are shown in Figures 5 and 6. It will be noted in Figure 5 that about 910,000 cubic feet of 700 pounds per square inch absolute gas was compressed to 950 psia gas by 2650 Mcf of 1375 psia motive gas. When the suction pressure on the well dropped to 600 psia, the same compressor with no alterations in nozzle or diffuser, compressed 700 Mcf of 600 psia gas with 2650 Mcf of 1350 psia motive gas. Figure 6 has been developed to show the quantity of suction gas that could be compressed to line pressure 950 psia as the suction gas pressure varied. The jet compressor in this field installation performed a duty which would call for conventional compression equipment requiring many times the amount of capital investment and operating expense.

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[3] Warner, C. W., "Gas Mixing with Jet Compressors," *Gas*, September, 1954, page 56.

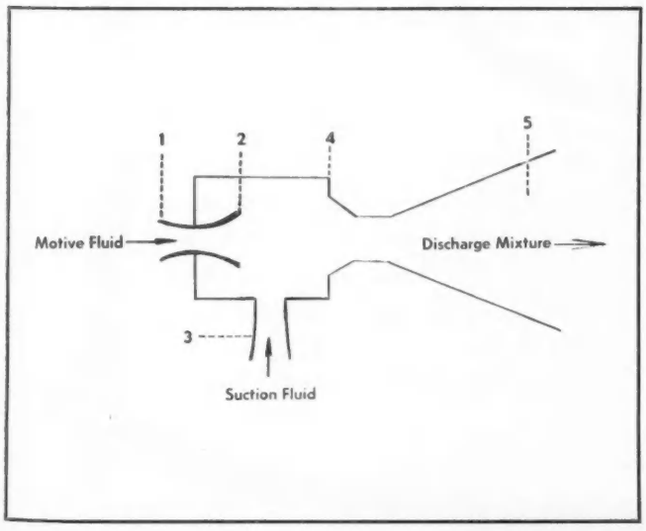


FIGURE 7—Schematic drawing of gas jet compressor to identify determination points used in calculations.

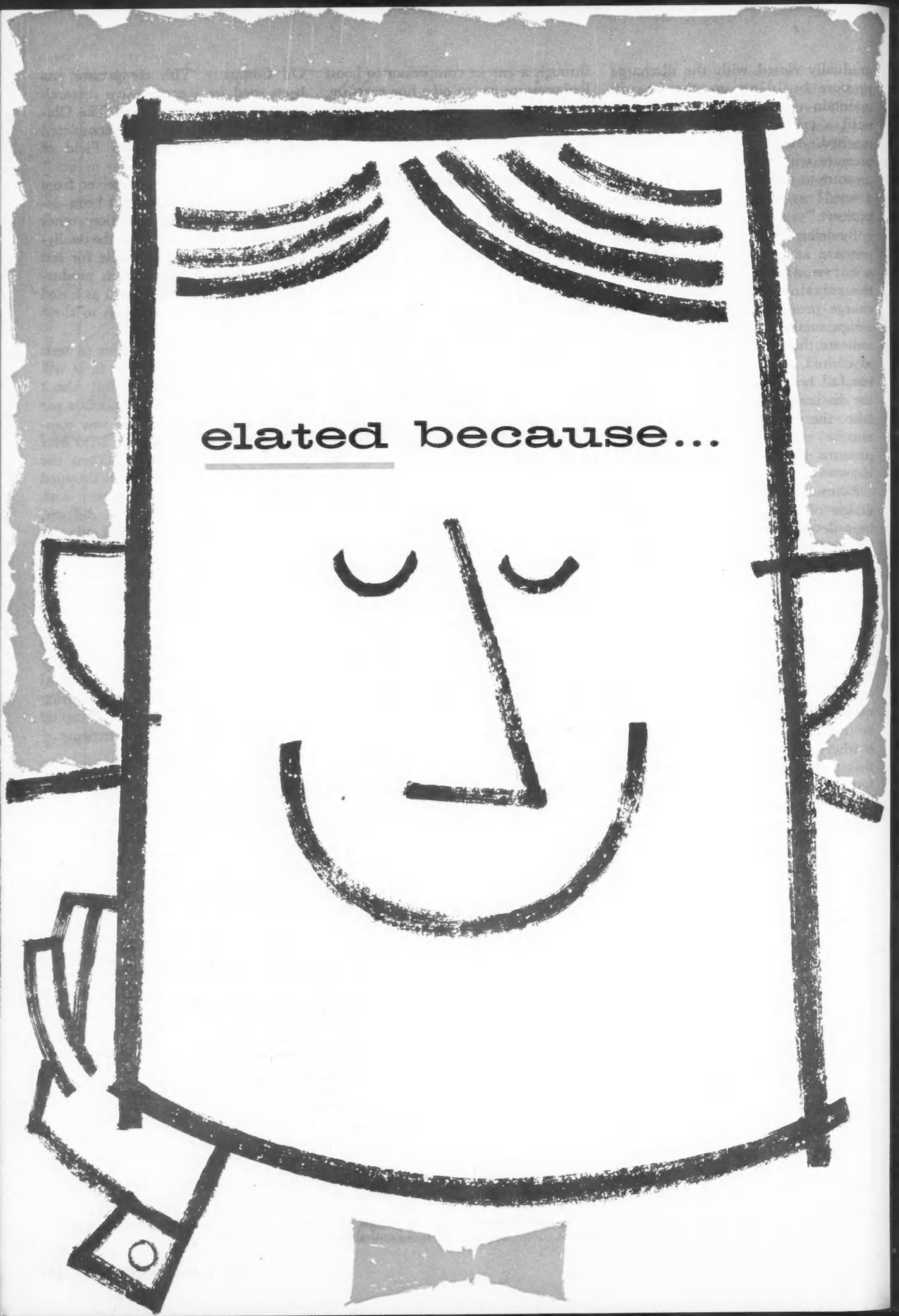
APPENDIX I—SECTION 1.
DEVELOPMENT OF FORMULA FOR THERMAL COMPRESSOR PERFORMANCE CALCULATIONS

I. Symbols:

- p — pressure, pounds per square inch absolute.
- T — absolute temperature, degrees Rankin.
- s — entropy, British thermal units per pound—degrees Rankin.
- C_p — specific heat at constant pressure, Btu/lb.—°R.
- k — ratio of specific heats, C_p/C_v.
- h — enthalpy, Btu/lbs.
- v — velocity, feet per second.
- w — pounds suction fluid compressed per pound motive fluid.
- g — gravity, feet per second^2.
- J — mechanical equivalent of heat, 778 foot-pounds/Btu.

II. Assumptions:

A. Flow is frictionless (viscosity of fluid is zero).
B. Expansion in nozzle and compression in diffuser are isentropic.
C. Motive fluid is the same as the suction fluid.
D. Calculations are based on 1 lb. of motive fluid.
E. Mixing occurs at constant pressure and is adiabatic.
F. Total enthalpy of the mixture is the average of the total enthalpies of the components.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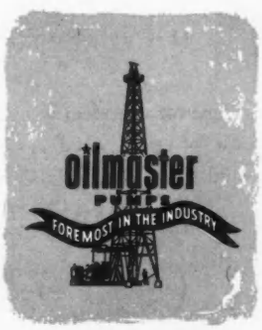

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G. Velocities at points 1, 3, and 5 (Fig. 7) are negligible compared to those at 2 and 4.

H. Pressure at 2, 3, and 4 are equal.

III. Methods of calculation:

A. Derivation of General Relations

1. According to assumption F,

$$(1+w)\,h_5 = h_1 + wh_3 = h_3 - h_3 + h_3\,(1+w)$$

$$h_5 = h_3 + \frac{h_1 - h_3}{1+w} \quad \ldots\ldots (1)$$

2. Applying assumptions A, B and G ($v_5 = 0$) to the equation expressing the conservation of energy for the diffuser yields,

$$h_4 = h_5 - \frac{v_4^2}{2gJ} \quad \ldots\ldots (2)$$

3. Applying assumption E to the equation for the conservation of momentum during the mixing process,

$$v_2 = (1+w)\,v_4 \quad \ldots\ldots (3)$$

Squaring both sides and dividing by 2gJ yields,

$$\frac{v_4^2}{2gJ} = \left(\frac{1}{(1+w)}\right)^2 \frac{v_2^2}{2gJ} \quad \ldots\ldots (4)$$

4. Applying assumptions A, B, and G ($v_1 = 0$) to the equation expressing the conservation of energy for the nozzle yields,

$$\frac{v_2^2}{2gJ} = h_1 - h_2 \quad \ldots\ldots (5)$$

5. Substituting equation (5) into (4) and the result into (2) gives

$$h_4 = h_5 - \frac{h_1 - h_2}{(1+w)^2} \quad \ldots\ldots (6)$$

B. Method of determining w as a function of p_5 if a Mollier, p-h, or other suitable state diagram is available for the gas or vapor.

1. Knowing h_1, h_3, and w, calculate h_5 from equation (1).
2. Calculate h_4 from equation (6).
3. From a Mollier chart, locate state at point 4 knowing h_4 and p_4.
4. Locate h_5 along isentropic from 4 (s = constant) yielding p_5.
5. Repeat steps 1-4 for different values of w.
6. From calculations of steps 1-5, plot curve of w vs. p_5 or w vs. p_5/p_4.

C. Determination of w as a function of p_5 based on perfect gas relations.

1. Derivation of Equation.

a. From equation (4),

$$(1+w)^2 = \frac{\frac{v_2^2}{2gJ}}{\frac{v_4^2}{2gJ}}$$

b. Since for a perfect gas,

$$\Delta h = cp\Delta T \quad \ldots\ldots (8)$$

and

$$\left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}} = \frac{T_2}{T_1} \quad \ldots\ldots (9a)$$

$$\left(\frac{p_4}{p_5}\right)^{\frac{k-1}{k}} = \frac{T_4}{T_5} \quad \ldots\ldots (9b)$$

equations (2) and (5) become

$$\frac{v_2^2}{2gJ} = CpT_1\left(1 - \frac{T_2}{T_1}\right) = C_pT_1\left[1 - \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}\right] \quad \ldots (10)$$

$$\frac{v_5^2}{2gJ} = CpT_5\left(1 - \frac{T_4}{T_5}\right) = C_pT_5\left[1 - \left(\frac{p_4}{p_5}\right)^{\frac{k-1}{k}}\right] \quad \ldots (11)$$

c. Substituting equations (10) and (11) into (7),

$$(1+w)^2 = \frac{T_1}{T_5}\left[\frac{1 - \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}}{1 - \left(\frac{p_4}{p_5}\right)^{\frac{k-1}{k}}}\right] \quad \ldots\ldots (12)$$

d. From equation (1)

$$\frac{T_5}{T_1} = \frac{T_3}{T_1} + \frac{1 - \frac{T_3}{T_1}}{1+w} \quad \ldots\ldots (13)$$

e. Substituting equation (13) into (12) and solving for w from the resulting quadratic equation,

$$w = \frac{1}{2T_3}\left\{\left[(T_1 - T_3)^2 + 4T_1T_3\frac{1 - \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}}{1 - \left(\frac{p_4}{p_5}\right)^{\frac{k-1}{k}}}\right]^{\frac{1}{2}} - (T_1 + T_3)\right\} \quad \ldots\ldots (14)$$

2. Procedure.

a. Substitute various values of p_5 into equation (14) and solve for w, keeping p_4, p_2, p_1, T_1 and T_3 constant.

b. Plot curve of w vs. p_5 or w vs. p_5/p_4.

APPENDIX I, SECTION 2
CALCULATIONS FOR THE DESIGN OF GAS-JET COMPRESSORS

Assumptions:

Line operating pressure = 700 psia = p_5
High-pressure (motive pressure) = 900 psia = p_1
High-pressure (motive gas) Temp. = 90° F.
High-pressure (motive gas) Sp. Gr. = 0.65
High-pressure (motive gas) K = C_p/C_v = 1.28 Btu/lb.° F.
Low-pressure (suction gas) = 500 psia = p_3
Low-pressure (suction gas) Temp. = 80° F.
Low-pressure (suction gas) Sp. Gr. = 0.65
Low-pressure (suction gas) K = C_p/C_v = 1.28 Btu/lb./° F.

Let N = K-1/K = 1.28 — 1/1.28 = 0.219

where

1. K = 1.28
2. A = p_2/p_1 = 500/900 = 0.555
3. $A^N = (0.555)^{.219} = 0.879$
4. p_4/p_5 = 500/700 = 0.714 = C
5. $C^N = (0.714)^{.219} = 0.929$

where (See Figure 10)

$p_2 = p_3 = p_4$ = 500 psia.
p_1 = 900 psia.
p_5 = 700 psia.

6. t_1 = 90° F. = 550° R. or T_1 = 550° R.
7. t_3 = 80° F. = 540° R. or T_3 = 540° R.
8. $A^NT_1 = 0.879 \times 550 = 483°$ R. or $T_2 = 483°$ R.
9. $T_1 - T_3 = 550 - 483 = 67°$ R.
10. $4T_1T_3 = 4 \times 483 \times 540 = 1.041 \times 10^6$
11. $(T_1 - T_3)^2 = 100$
12. $(1 - A^N) = 1 - 0.879 = 0.121$
13. $(1 - C^N) = 1 - 0.929 = 0.071$
14. W = lbs. of suction fluid compressed per lb. of motive fluid

$$W = \frac{1}{2T_3}\left\{\left[(T_1 - T_3)^2 + 4T_1T_3\left(\frac{1 - A^N}{1 - C^N}\right)\right]^{\frac{1}{2}} - (T_1 + T_3)\right\}$$

$$W = \frac{1}{1080}\left\{\left[100 + 1.041 \times 10^6\left(\frac{0.121}{0.071}\right)\right]^{\frac{1}{2}} - 1090\right\}$$

W = 242/1080 = 0.224 with 100 percent efficiency.

Assuming an efficiency of 65 percent through Venturi Section:

$$W = .224 \times 0.65 = 0.145\ \frac{\text{lbs. suction gas}}{\text{lbs. motive gas}}$$

1/W = 1/.145 = 6.9 lbs. of motive/lb. of suction gas
Vol/Vol = 6.9 Mcf motive gas/Mcf suction gas
2.5 Mmcf/day of motive will compress 362 Mcf/day of suction gas
Total flowing into line = 2.5 + 0.36 = 2.86 Mmcf/day
3 Mmcf/day of motive will compress 435 Mcf/day of suction gas
Total flowing into line = 3.435 Mmcf/day.
3.5 Mmcf/day of motive gas will compress 506 Mcf/day of suction gas
Total flowing into line = 4.06 Mmcf/day.

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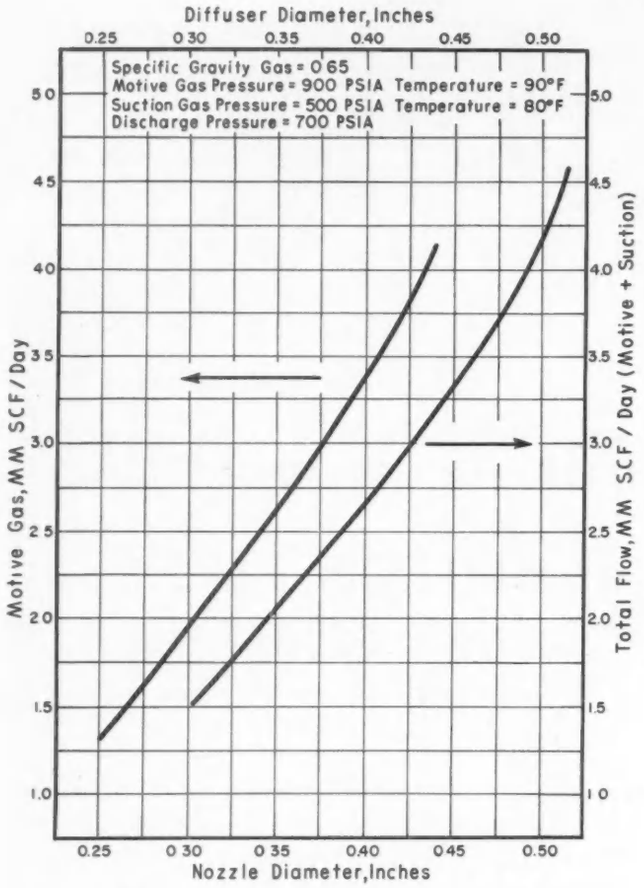


FIGURE 8—Relationships of nozzle diameter to total flow and diffuser diameter to rate of motive gas flow for one set of conditions noted on the curve.

Nozzle Design

1. Standard cu. ft./lb. motive gas $= \frac{379}{28.96 \times 0.65}$

   $= 20.15$ cu. ft./lb.

2. $\frac{2.5}{20.15}$ Mmcf/day motive gas $= 124{,}000$ lbs./day

   $\frac{124{,}000}{24 \times 60 \times 60} = 1.44$ lbs./sec. $=$ weight

3. $v_1 = 20.15$ cu. ft./lb. $\times \frac{14.7}{900} \times \frac{550}{520} = 0.347$ cu. ft./lb.

4. $v_2 = v_1(p_1/p_2)^{1/k} = 0.347 \times \left(\frac{1}{.555}\right)^{\frac{1}{1.28}} = 0.55$ cu. ft./lb.

5. $V_2 = \sqrt{\frac{2gk}{k-1}(p_1v_1 - p_2v_2) + V_1^2}$

Assuming upstream velocity V_1 in flow line (neg.)

6. $V_2 = \sqrt{\left(\frac{2gk}{k-1}\right)(p_1v_1 - p_2v_2)} =$

$$\sqrt{\left(\frac{2 \times 32.17 \times 1.28}{1.28 - 1}\right)(900 \times 144 \times .347 - 500 \times 144 \times .55)}$$

$= 1250$ ft./sec.

7. $A_2 = \frac{Wtv_2}{V_2} = \frac{1.44 \times 0.55}{1250} \times 144 = 0.0912$ sq. in.

8. $A_2 = \frac{\pi d^2}{4}$ $\qquad d = \sqrt{A^2 \frac{4}{\pi}} = \sqrt{\frac{.0912 \times 4}{A}}$

$= 0.341$ in.

Diffuser Design

1. scf/lb. $= 20.15$ cf/lb.

2. $362{,}000/20.15 = \frac{18{,}000}{24}$ lb./day $= \frac{750}{60} =$ lb./hr. $=$

   12.5 lb./min. $12.5/60 = 0.208$ lb./sec. suction gas

3. $W = 0.145$ lb. of suction gas per pound of motive gas

4. $T_3 = T_1\left[\frac{T_2}{T_1} + 1 - \frac{T_2}{T_1}\right] = 550\left[\frac{540}{550} + 1 - \frac{540}{550}\right] = 548°$ R.

   $1 + w \qquad\qquad 1 + .145$

5. $v_3 = 20.15 \times \frac{14.70}{700} \times \frac{548}{520} = 0.446$ cu. ft./lb.

6. $v_4 = 0.446 \left(\frac{700}{500}\right)^{\frac{1}{k}} = 0.446\ (1.4)^{.782} = 0.582$ cu. ft./lb.

7. $A_4 = \frac{(1.44 + 0.208)\ 0.582 \times 144}{1250 \times 0.85} = 0.130$ sq. in.

   where $0.85 =$ coefficient of discharge

8. $d_4 = \sqrt{\frac{4 \times 0.130}{3.1416}} = 0.406$ in.

   3 MM scf/day (motive) $\qquad$ 0.435 MM scf/day (suction)

   Weight of motive $= \frac{3\text{ MM}}{20.15 \times 24 \times 60 \times 60} = 1.73$ lb./sec.

   $A_{(nozzle)} = 0.11$ sq. in. $\qquad d = \sqrt{\frac{0.11 \times 4}{\pi}} = 0.374$ in.

   3.5 MM scf/day (motive) $\qquad$ 0.506 MM scf/day (suction)

   Weight of motive $= \frac{3.5\text{ MM}}{20.15 \times 24 \times 60 \times 60} = 2.02$ lb./sec.

   $A_{(nozzle)} = 0.1285$ sq. in. $\qquad d = \sqrt{\frac{0.1285 \times 4}{\pi}} = 0.405$ in.

   $(1.73 + 0.25) = 1.980$ total flow lb./sec.

   Diffuser diameter $= 0.406 \sqrt{\frac{1.98}{1.648}} = .445$

   $(2.02 + 0.292) = 2.312$ total flow lb./sec.

   Diffuser diameter $= 0.406 \sqrt{\frac{2.312}{1.648}} = .48$

   General Equation.

   Nozzle diameter $= 0.341 \sqrt{\frac{Q\text{ M scf/day}}{2500}}$

Diffuser diameter $= 0.406 \sqrt{\frac{(Q_{motive} + Q_{suction}) \times M\text{ scf/day}}{(2500 + 362)}}$

900 psia motive pressure
500 psia suction pressure
700 psia discharge pressure

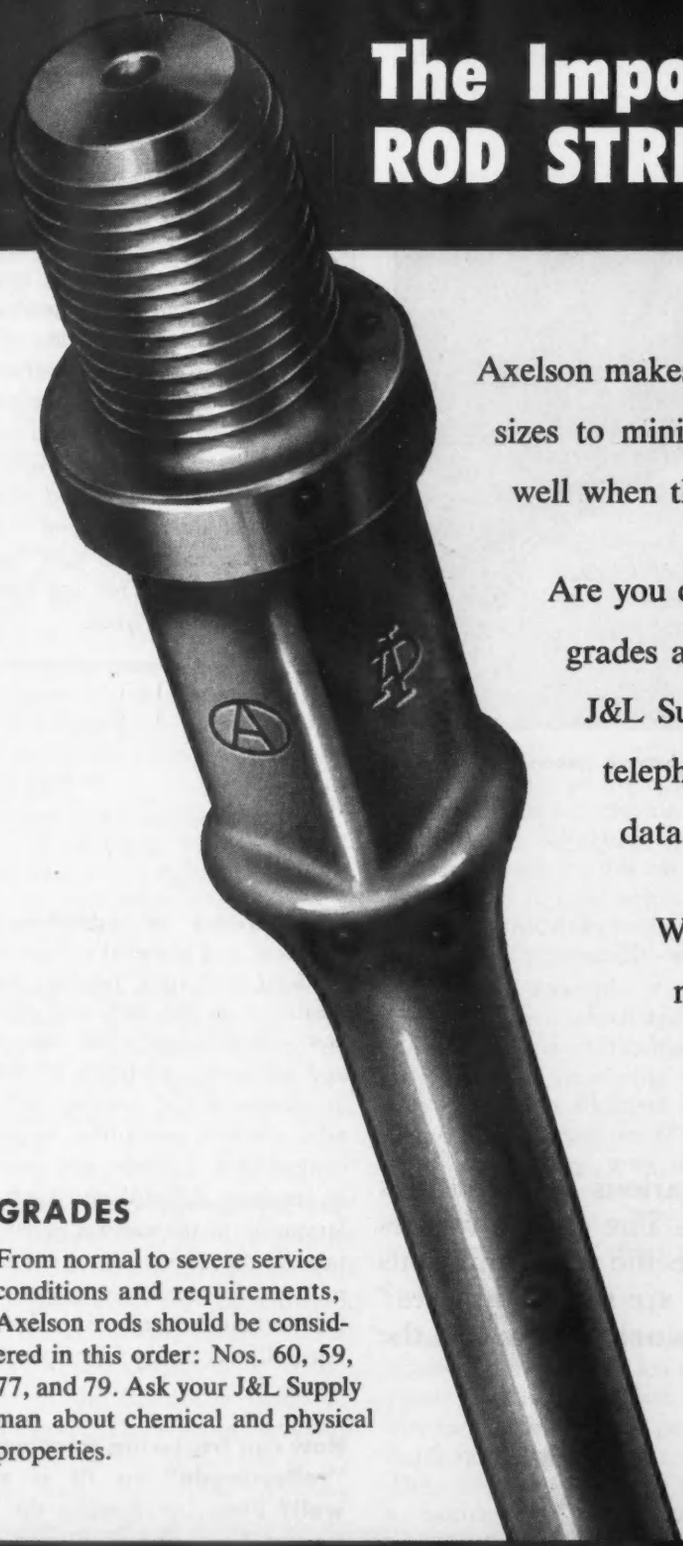
Motive Gas scf/day	Suction Gas scf/day	Nozzle Diameter inches	Diffuser Diameter inches
2500 Mcf/day	362 Mcf/day	0.341	0.406
3000 Mcf/day	435 Mcf/day	0.374	0.445
3500 Mcf/day	506 Mcf/day	0.405	0.480
2000 Mcf/day	290 Mcf/day	0.306	0.363
1500 Mcf/day	218 Mcf/day	0.264	0.315
4000 Mcf/day	580 Mcf/day	0.433	0.514

ACKNOWLEDGMENT

The authors wish to acknowledge the help and encouragement in this work by Walter B. Saner, James G. Badgett and Roy A. Schuster of The Chicago Corporation, and James E. Pew of Sun Oil Company.

—The End

The Importance of ROD STRING SELECTIONS



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SELECTION of proper additives often spells the difference between success and failure in fracturing problem wells.

No one engaged in the multitude of tasks relating to petroleum production can keep all the facts and figures in his head. Books, guides, files, etc. must be resorted to as a means of keeping important details at your fingertips. It is always a help, therefore, when an author can present information of value in a concise manner, making the part you need readily available. This is such an article. It is recommended as material not just to read and understand but to add to your file of production data for use tomorrow . . . or next year.

Chemical Additives Improve Fracturing

Water, oil and acid in various combinations are being used to fracture formations. The characteristics of these fluids can be controlled for specific well conditions by the use of certain additives. What are these additives? What can they do? How do they work? Here are the answers.

By A. W. COULTER
Dowell Incorporated
Tulsa

What are additives? Additives are chemical materials, active or inert, which may be added to a fracturing fluid in order to impart useful properties to the fluid and improve results of the treatment.

Why are they necessary? All wells have individual characteristics that affect the extent to which the well will respond to fracturing. These characteristics must be considered in planning a treatment, in order to obtain maximum well stimulation.

What well characteristics determine choice of additives? The chemical and physical composition of the formation rock; porosity and permeability of the pay, and other exposed zones; formation temperature and pressure; solubility of the rock in various acids; presence of bentonitic silicates susceptible to swelling; composition of crude, and prevalency of emulsion difficulties; structural relationship of the various mineral crystals in the formation; presence and nature of secondary deposition in flow channels; and extensiveness of naturally occurring fractures or weaknesses.

How can fracturing treatments be "tailor-made" to fit a specific well? First, by choosing the proper type of fracturing fluid; and second, by selecting suitable additives.

What are the principal types of fracturing fluids? In general, they can be classified as oil-base, aqueous-base (water or acid), and mixed-base (emulsions).

What materials are used as oil-

base fluids? Refined oils, lease crude, and various artificially thickened oils, either refined or crude.

What are refined oil fracturing fluids? Refined oils are specific cuts from fractionating towers, or specific blends of various cuts. Usually, a viscous recycle oil is used. For some applications, however, lighter fractions such as kerosene or diesel fuel are employed. Such materials have the advantage of being readily obtainable with uniformly predictable physical and chemical properties. The cost is less than that of many other types of fracturing fluids, and the oil, being of pipe line quality, is largely recoverable following the treatment.

Such oil-base fluids are valuable in formations containing silicates that are likely to swell, as no water need be injected into the formation. Also, emulsion difficulties are less likely to be encountered, because most of the natural emulsifying components of the oil have been removed during the refining process.

The principal disadvantage of a refined oil fracturing fluid is its tendency to thin out at high well temperatures, which reduces its sand-suspending ability.

What additives are used with refined oils? The principal additives used are fluid-loss-control agents, demulsifying agents (when necessary), and thickening agents (with lighter fractions).

When are fluid-loss-control additives used? Their use is especially recommended where formations with high permeability are encountered. These agents provide more efficient and economical operation by reducing loss of the fracturing fluid into the formation. Three types are available for use in oils. Although all are effective, one is sensitive to water contamination and is limited to use in water-free oils.

When are demulsifiers necessary? It would not seem reasonable that injecting a refined oil into an oil-producing formation could produce an emulsion. In some formations, however, emulsion difficulties have been encountered, apparently resulting from a disruption of the water-oil interface during fracturing. The use of oil-soluble demulsifying agents in such trouble areas has prevented, or at least minimized, such emulsion difficulties and has increased the yield of recoverable oil.

A typical example is the Bartlesville formation, which has frequently given emulsion difficulties, in both acidizing and fracturing treatments. Use of suitable additives has greatly reduced the occurrence of such emulsions. Laboratory tests or previous experience can be used as a basis for selecting the demulsifying agent which will be most effective in a particular area.

When are thickening agents used? Lighter petroleum fractions (such as kerosene, diesel fuel oil, or distillate) may be used as fracturing fluids rather than viscous, refined oil. They are frequently used in gas wells to assure more nearly complete return of the fracturing fluid following treatment. Also, the more viscous fracturing oils may not be readily available in some areas. A thickener is often added to these lighter oils to provide better sand-suspending properties.

What types of thickeners are used? In general, they fall into two classifications, aluminum-type soaps and sodium-type soaps. Gels made with aluminum type soaps are highly sensitive to contaminants and require careful proportioning of ingredients. If too much agent is used, high friction losses are encountered in pumping the thickened oil down the well; while if too little agent is used, the sand may settle out.

This type of gel is difficult to control, both in mixing and handling, and other additives (fluid loss, demulsifiers, etc.) cannot be used with it. Such gels exhibit high fluid-loss properties. A further disadvantage is that a subsequent gel-breaker fluid is required in order to obtain proper returns following the fracturing treatment.

The sodium soaps form a more stable gel which is characterized by good sand-supporting properties and low friction losses during pumping. The soap also provides low fluid-loss properties to the oil, which in most cases is desirable. Such gels are easy to prepare, are compatible with well fluids, and break naturally by dilution with formation fluids.

When are crude oils used for fracturing? The chief advantage of using lease oil as a fracturing fluid is that it is cheap and is usually readily available. However, due to its extremely high fluid loss and lack of sand-supporting ability, screen-outs are very apt to occur unless extremely high injection rates are employed.

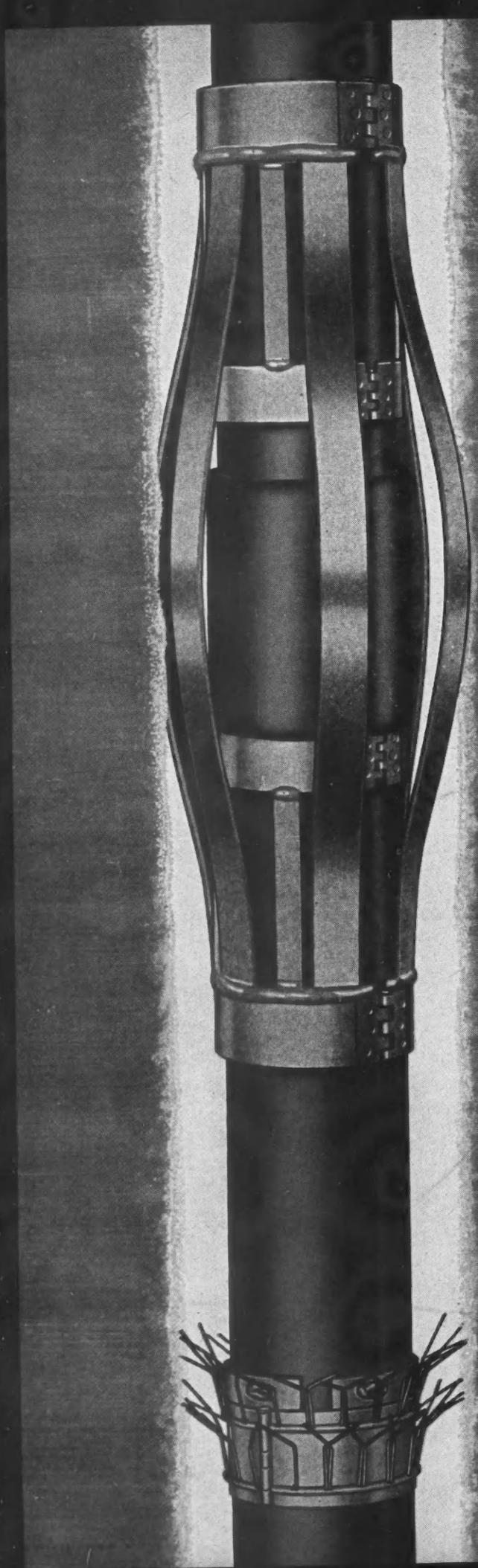
In addition, the presence of volatile components increases the fire hazard during pumping operations. If native crude is not available, oil from a different formation may result in serious emulsion difficulties unless proper precautions are taken.

Can crude oils be modified for fracturing use? Yes. The previously described sodium-soap type of thickeners will provide adequate sand-supporting properties, without excessive friction losses during injection. In addition, reasonably low fluid-loss properties are achieved, although the use of a supplemental fluid-loss additive is recommended for fracturing highly permeable formations.

The use of an after-flush of oil containing a suitable demulsifying agent is recommended. This serves to dilute the thickened crude oil and

About the Author

A. W. COULTER obtained his B.S. degree, with honors, from the University of Tulsa in 1945. After joining Dowell Incorporated as an analytical chemist in the same year, he was successively promoted to research Chemist, group leader, and to his present position as a senior chemist. He is a member of the American Chemical Society.



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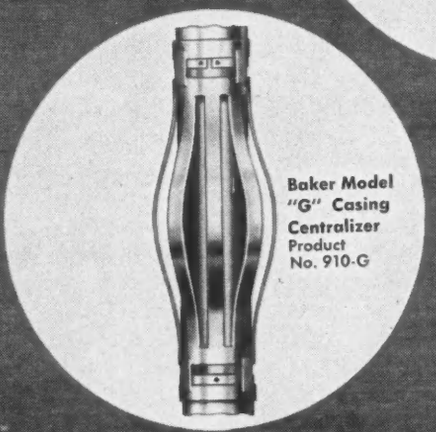

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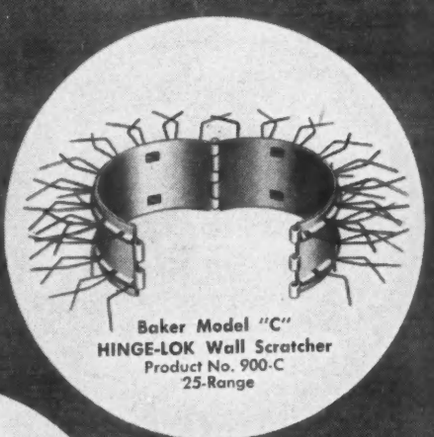

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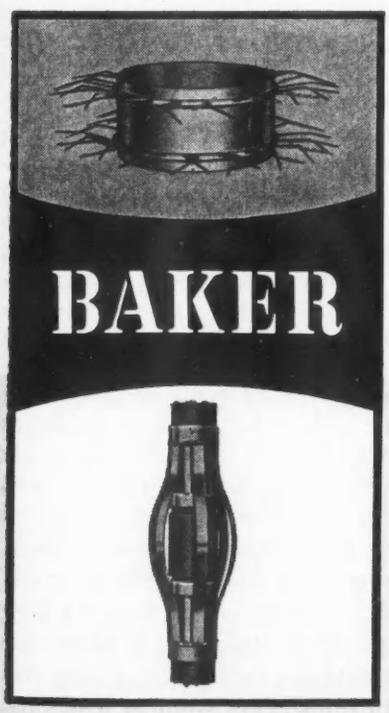

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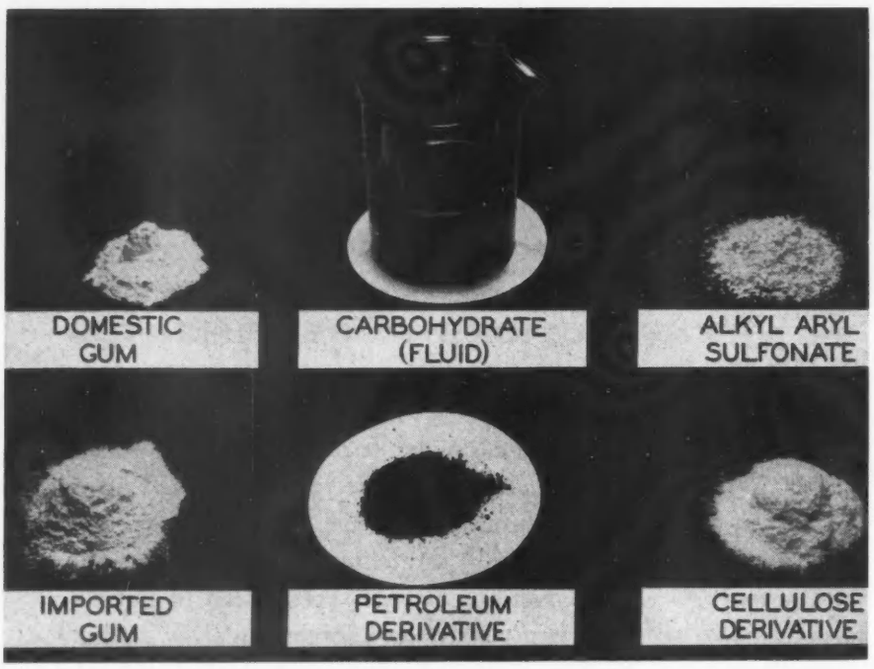

FIGURE 1—A number of different additives have been developed for use in various fracturing fluids to thicken them and reduce fluid loss.

assure its return following the treatment.

What are aqueous-base fracturing fluids? These fall into two classifications, water and acid. Usually a thickening agent of some type is required in order to provide sufficient viscosity to suspend the sand during the fracturing treatment. Recently, however, highly successful fracturing treatments have been conducted in the West Texas and Permian Basin areas using unthickened water or very dilute acid solutions.

Is unthickened water a good fracturing fluid? Unthickened water has one outstanding advantage—it is cheap. Its disadvantages are that it has extremely high fluid loss and practically no sand-carrying ability. These drawbacks can be overcome by injecting the fracturing materials at high rates of speed (30 barrels per minute or higher) to avoid sand "screen-outs." One additional advantage of fresh water as a fracturing agent is that it can dissolve deposited salt from the formation flow channels.

What is the principal application for water-type fracturing fluids? Other than the high-injection rate treatments described above, these are principally used in water wells, where pumping oil into the producing formation would be undesirable. In the case of potable water wells, the additional precaution of using only nontoxic agents, to avoid any contamination of later production, must be observed.

How is water thickened for use as a fracturing fluid? The thickening agents used fall into two classifications, natural and synthetic gums. Bacterial cultures are added to the gels formed with natural gums. The resulting bacterial action destroys the gel following the treatment, assuring complete return. The gels made with synthetic gums, in contrast, are slightly alkaline in nature, and are thinned by dilution with formation brine, and the resulting decrease in pH.

What other additives are used with water? The natural gum thickeners also reduce the fluid loss of the water fracturing fluid. When using synthetic gums, an additional control agent must be used if low fluid-loss characteristics are desired.

Demulsifiers are usually added if a water-type fracturing fluid is to be used in an oil-bearing formation. In such cases, surface-tension-lowering agents also may be used to provide increased penetration and to facilitate return of the fracturing fluid.

What acid-type fracturing fluids are used? These consist of hydrochloric acid solutions, usually containing a thickening agent of some kind to produce a sand-carrying gel. As with water, these thickeners are natural gums or various synthetic polymers (Figure 1). These thickeners increase the viscosity of the acid, improve its sand-carrying ability, and usually lower its fluid loss. Otherwise they do not affect the chemical properties of the acid.

Therefore, in acid-soluble formations, the combined stimulation benefits of acidizing and fracturing may be obtained. Even in sandstone or other normally insoluble formations, the removal of secondary lime deposits from flow channels may result in material improvement in formation permeability.

What other additives are used in acid-type fracturing fluids? Other materials used include demulsifying agents, surface-tension-lowering agents, silicate-swelling-control agents, and intensifiers.

The use of demulsifiers is important in fields known to have given emulsion difficulties during previous acidizing or fracturing treatments. In new areas, laboratory tests are recommended, not only to determine whether such additives are needed, but also to establish which of the available agents will be most effective with the specific crude involved.

Surface-tension-lowering agents are used to facilitate penetration of the acid into the oil-bearing formations and to assure complete return of the spent acid following the fracturing treatment.

Silicate-control additives should be used wherever clay or silicate particles are present in the formation being fractured. Two types of silicate control additives are available. One, an organic salt, is especially recommended where the clay content is extremely high, such as in a sandstone or limey-sandstone formation. The second type, a surface-active agent that makes the silicate particles water-repellent, is recommended for limestone, dolomite, sandy-limestone, or sandy-dolomite. The purpose of these agents is to minimize the swelling of clay particles upon contact with the spent acid. Such swelling might offset some of the advantages derived from the fracturing operation.

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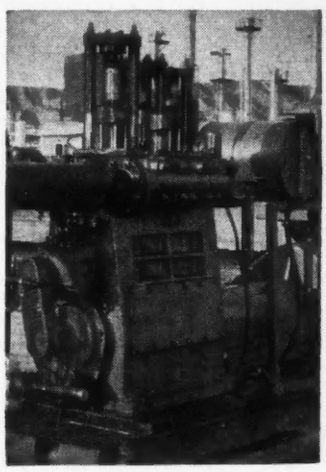

Shown above is one of a number of Aldrich 5" stroke, Triplex Pumps installed at a major west coast water injection project. These pumps are currently handling 35,000 bbl daily at injection pressures of 1,000 psi.

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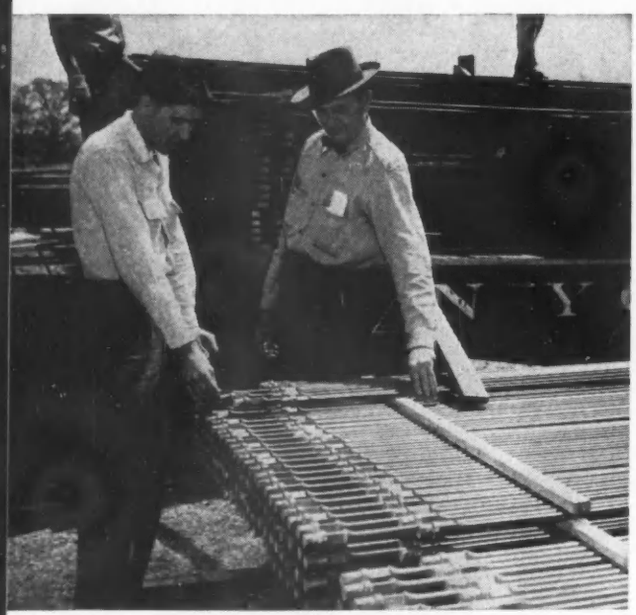
OPEN HOUSE. At the opening of new district offices for Continental Oil Company at Eunice, New Mexico, this was the reception committee: (left to right) Ruth Carter, Bob Gault, Janelle Johnson, Patsy Marshall, Joe Habelman, Donnie Niales, Hal Cox, and George Cummings. Conoco now has two district offices in New Mexico; the other is at Hobbs.

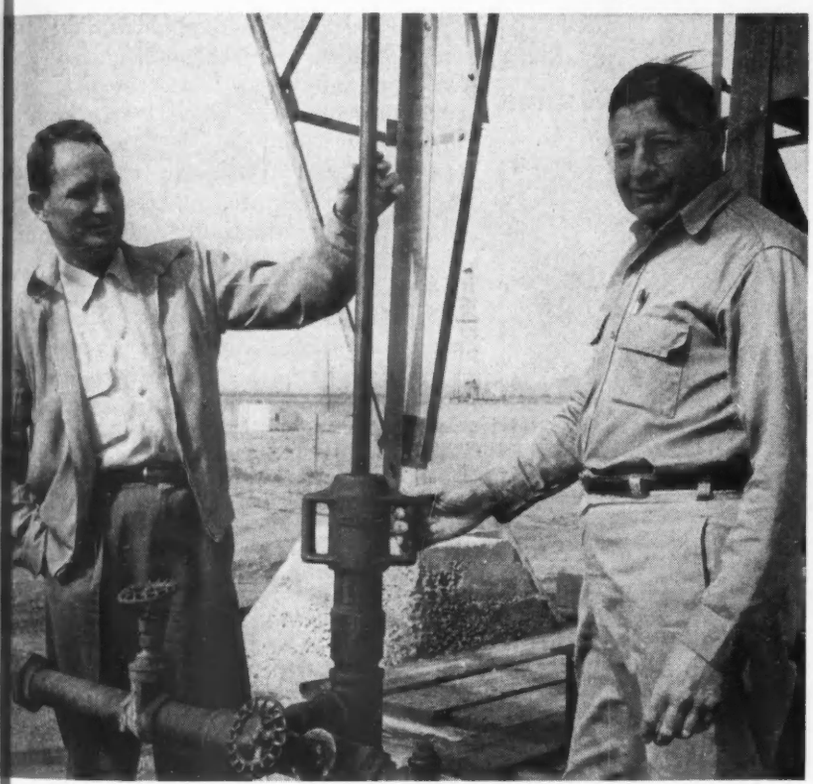


35,000 FEET. Unloading a carload of Axelson Sucker Rods at the J&L store in Shreveport, Louisiana, are C. F. Haman (right), Store Manager, and W. L. Holloway, Pelican Trucking Company. The shipment weighed 23 tons and consisted of 35,000 feet of #59 and #60 pin and pin rods in ⅝" and ¾" sizes, about a two-month supply.

FREELOADER. This was the coffee and sandwich bar at Continental Oil Company's Open House in the new district offices at Eunice, New Mexico. Conoco's charming secretaries serve the boss, W. E. Allen, Superintendent of the newly opened Eunice district. Hostesses are Patsy Marshall, Donnie Niales, Janelle Johnson, Ruth Carter.

WHAT'LL YOU HAVE? Buying pump parts for Alice Johnson #4 in the Muenster Field, Cook County, Texas, is F. E. Heath (right), District Foreman for General American Oil Company of Texas. An Axelson Plunger Pump was installed in this well in 1944 and is still pumping. Because of a severe corrosive condition, it is pulled every three months, reworked and rerun into the well. D. C. Jones, J&L Manager of the Muenster store, writes up the order.

BOOM. This well (Mrs. Jessie Brown et al No. 1) was the discovery well for the Kelley-Snyder Field in Scurry County, West Texas, for Standard Oil Company of Texas. Completed November 1948, it was responsible for the great Snyder boom of 1949-50. It is now a water-injection well for the SACROC unit, the largest utilized operation in the world. Many Axelson 2″ (1½″) Sure-Seal and 2″ (1¼″) RL Pumps are at work in this field. (Left to right) Bob Hand, District Engineer; Norman Phillips, Production Foreman; George Ator, Production Clerk, all of Standard of Texas, and Forrest Goin, Axelson Representative.



SINCE '24. Looking over the Mitchell #1 in the Wellington Field at Fort Collins, Colorado, are Emmet Richman (right), Production Foreman, Fort Collins Producing Company, and Tom Mayo, Axelson District Manager. The 4,200 ft. well makes 220 B/D (10 bbls. net of 35 gravity oil) with an Axelson 2½ x 2 x 12 RWT Sure-Seal – the ideal pump for water flooded wells. Richman has been using Axelson equipment since 1924.

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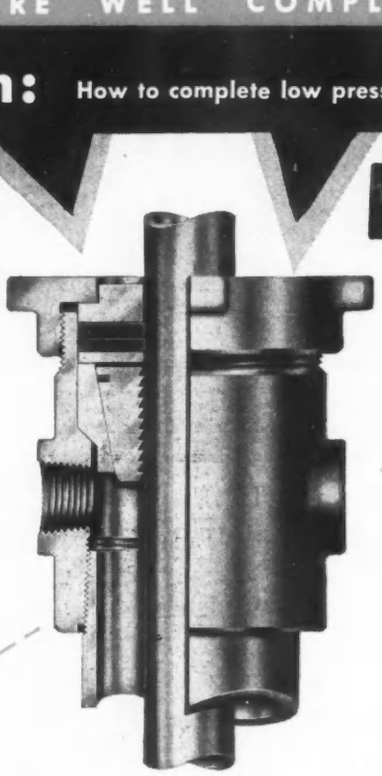

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See Gulfco's 20-page section in the Composite Catalog.

part the silicate-dissolving properties of hydrofluoric acid to the fracturing fluid. Such agents have long been used in acidizing formations with limited acid-solubility.

In applications where a very low-fluid-loss fracturing material is desired, a number of different additives are available to supplement the fluid-loss reduction by the thickening agent. The choice of additive is usually governed by the specific well problem to be overcome.

What are mixed-base fracturing fluids? They consist of oil and water (or acid), one of which is dispersed into the other to form an emulsion. This increases the apparent viscosity of the liquids, imparting excellent sand-carrying characteristics to the mixture without a major increase in friction losses during pumping.

There are two distinct physical types of emulsions used in fracturing operations. In one type, the acid or water is the inner phase (droplets surrounded by oil). In the other, oil is the inner phase, surrounded by the aqueous component. In general, in order to obtain a thick emulsion, the proportions of the two immiscible liquids are unbalanced, with the smaller quantity of liquid making up the outer phase. Such mixtures are usually referred to as water-oil emulsions, or oil-water emulsions, the first-named component being the inner phase.

A large number of emulsions have been developed to meet various well conditions. Each has its own advantages and disadvantages, and applications to which it is best suited. Principal differences are in the proportions and composition of the two liquid components and their relationships to each other (inner or outer phase).

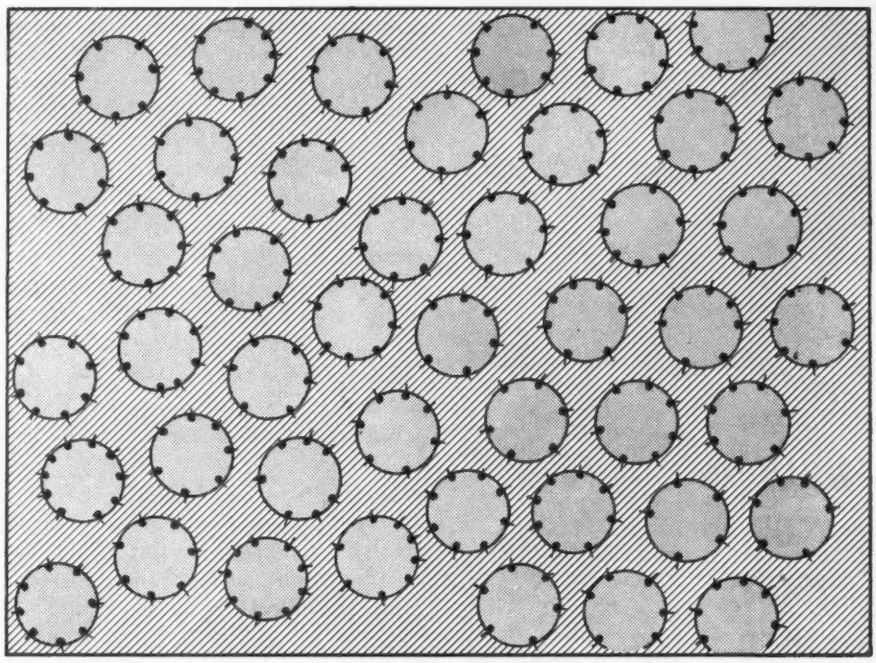


FIGURE 2—Emulsifying agents are chemicals which form a film around the emulsion droplets, preventing them from recombining.

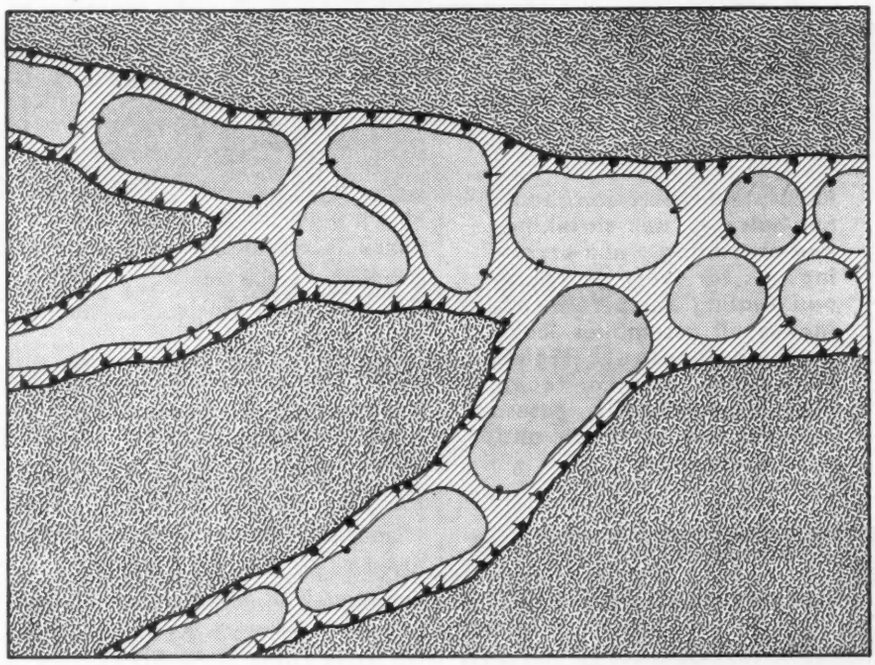


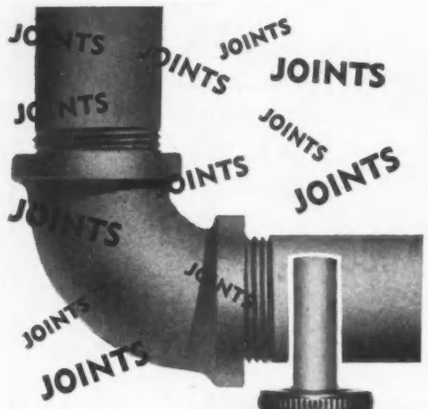
FIGURE 3—In the formation the emulsifying agents are absorbed on the formation surfaces, allowing the emulsion to "break out."

What are the principal types of emulsions used for fracturing? In general, they fall into two main classifications, acid-oil emulsions and oil-water emulsions. In the first category, the proportion of the acid phase varies from 65 percent to 95 percent in different formulations. (For example, an emulsion consisting of 65 percent acid and 35 percent oil, or the extreme condition in which 95 percent is acid and 5 percent oil.) Oil-water emulsions in common use consist of approximately 95 percent oil and 5 percent water. In rather limited use is an oil-acid emulsion consisting of 50 percent oil and 50 percent acid, but having the acid as the outer phase.

What additives are used with emulsion-type fracturing fluids? The principal additive present in all emulsions is a stabilizer or emulsifying agent. Unless such a chemical agent is used, the emulsion quickly "breaks," reverting to the original unmixed components. The type of emulsifier used affects the characteristics of the resulting emulsion.

Other additives used in the mixed-base fracturing fluids include fluid-loss-control agents, silicate-control agents, and (in emulsions containing acid) intensifying agents.

How do emulsifiers work? The materials used for this purpose are known as polar chemicals. The individual molecules are chain-like and the ends are differentiated; in effect,



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one end of the molecule is a water-soluble and the other end is oil-soluble. As a result, when an emulsion has been formed by the agitation of oil and water (for example), the molecules align themselves at the interface of the droplets, with each end in the appropriate liquid. A film of emulsifier molecules forms around each separate droplet, preventing it from reuniting with nearby droplets and thus stabilizing the emulsion.

This is shown schematically in Figure 2. The emulsifying agent is represented as small black dots with tails. In this example, acid is emulsified in small droplets, surrounded by oil. The heads (water-soluble) of the emulsifying agent are all in the acid phase of the emulsion, and the tails (oil-soluble) are all in the oil phase.

How are such emulsions broken?

The choice of emulsifying agent must be made carefully so that, following the fracturing treatment, the emulsion will revert to its individual non-viscous components and return readily to the well bore. This may be accomplished in two ways. In one case, an agent is used which acts as an emulsifier in an acid solution, but which is chemically altered by the spending of the acid on the formation so that it no longer stabilizes the emulsion.

The second mechanism by which emulsions are broken is that of adsorption. That is, an agent is chosen that will preferentially adsorb onto the face of the formation flow channels, allowing the individual droplets to coalesce, breaking the emulsion. This action is shown schematically in Figure 3. As the acid droplets lose their protective film of emulsifier molecules, they start joining together, forming two separate phases, acid and oil.

When are other additives used?

Fluid-loss additives may be used when extremely low-fluid-loss properties are desired. Actually, emulsion-base fracturing fluids have inherently low fluid loss. This property does not show up on the standard API fluid-loss test, through filter paper. Comparative measurements of the fluid loss of various fracturing fluids into rock, show these emulsions to have low fluid-loss properties. Results of tests on typical fracturing materials are shown in Table 1.

Although the use of emulsions might be expected to cause formation blocks, their inherent instability causes them to break and return readily. In some trouble areas, fine silicate particles may be freed from the formation by the action of the acid. In such cases, these particles may act as stabilizers to produce emulsion difficulties. This may be avoided by the inclusion of suitable silicate control additives in the fracturing fluid.

In formations of low solubility, intensifiers are often included in the acid phase of the emulsion to promote increased reaction with the silicate components of the rock.

Does this article cover all additives used in fracturing fluids?

No, but it does describe all of the more commonly used addition agents. Some other general classifications are temporary plugging agents to divert fracturing materials from highly permeable zones into tighter sections; specialized plugging materials to hold back incompetent sand formations, but still allow the production of formation fluids; and radioactive tracers, either liquid or solid, for the purpose of later establishing the exact location of the fracture or fractures by means of a subsurface Geiger-counter detection tool.

TABLE 1

Fluid Loss Tests

Comparative determinations of fracturing fluids at 100 psi. pressure (75° F.) against filter paper and rock.

FLUID	METHOD OF TESTING		
	API Code No. 29	With Rock Core* 1 In. Long	(3½ In. Dia.) 3 In. Long
Kerosine	300 ml./11 sec.	300 ml./72 sec.	300 ml./2 min. 33 sec.
Acid-Oil Emulsion	300 ml./34 sec.	25 ml./30 min.	0 ml./30 min.
Oil-Water Emulsion	300 ml./41 sec.	210 ml./30 min.	80 ml./30 min.

* Tests run using a Berea sandstone core (200 md.)

—The End

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The Liquefied Petroleum industry is flashing one of the most phenomenal growth records on the industrial scene today. From one million in 1940, consumers of this heat-rich, clean fuel have multiplied to nine million.

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The uses of LP gas are numerous and expanding. On the farm, it performs such chores as cooking, heating, refrigeration, machinery and tractor propulsion, crop drying and weed-burning—and now air conditioning.

In addition to this growing LP gas market for these pressure vessels made of Sheffield steel components, another big potential market looms up in the handling of liquid fertilizer. It seems a certainty the demand for pressure vessels will continue. If you have an active interest in this booming industry let us tell you how we can serve your need.

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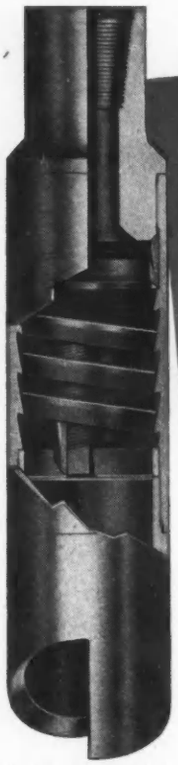
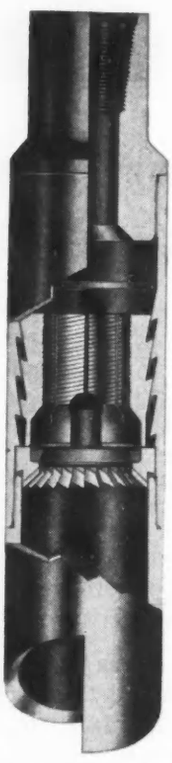


Series 150 Overshot Dressed with Spiral Grapple and Parts

The Bowen "Grapple Grip" Principle



Series 150 Overshot Dressed with Basket Grapple and Parts

SERIES 150 (SINGLE BOWL) BOWEN Releasing and Circulating OVERSHOT

Series 150 (Single Bowl) Bowen Releasing and Circulating Overshots are compact units made up of a Top Sub, a Bowl, and a Guide. They can be dressed with standard parts to engage and pack off a specific maximum size or with undersize parts to engage and pack off any smaller sizes.

SIMPLE AND EASY TO DRESS If the OD of the fish is close to the maximum catch of the Overshot, only three parts are required to dress the Overshot to engage and pack it off—a Rubber, a Spiral Grapple, and a Grapple Control. The Rubber drops easily into place in the top of the Bowl.

If the OD of the fish is somewhat below the maximum catch of the Overshot, *only two parts* are required to dress the Overshot to engage and pack it off—a Basket Grapple and a Control Packer. If the top of the fish is apt to be burred or ragged, a Mill Control Packer is used in place of the Control Packer. The teeth will trim the fish and insure perfect performance of the replaceable rubber element and the Grapple. These parts assemble quickly and easily into the Bowl from its lower end. They cannot be assembled incorrectly.

Basket Grapples are a most efficient means for engaging external upset sections or couplings as they can be provided with a solid steel stop in their upper ends to insure location of the fish within their wickered areas.

SETTING AND RELEASING TO THE RIGHT PROVIDES UTMOST SAFETY

The Bowen Overshot both sets and releases TO THE RIGHT so that the fishing string is never turned in an unscrewing direction — a vital safety point.

Positive Grip: When the top of the fish is reached, only slow right hand rotation and simultaneous lowering is required to properly locate the fish within the Grapple and Rubber. Thereafter when the string is elevated, the Grapple grips firmly and evenly over a large area of the fish in much the same manner that the "Chinese handcuff" illustrated here-with tightens when pull is exerted. As pull is increased, the grapple tightens about the fish—the greater the pull, the tighter the grip—without danger of distorting the fish.

Positive Release: To release, merely bump down, then rotate slowly to the right and simultaneously elevate the fishing string until the overshot is off the fish. The right hand rotation will cause the grapple to expand and actually let go of the fish — the operator does not have to depend on the ability to unscrew from a fish.

SIMPLE ACCESSORIES PROVIDE GREAT VERSATILITY

EXTENSIONS: Installed between Top Sub and Bowl of Overshot to allow tool to be lowered over fish with unengageable upper end.

OVERSIZE GUIDES: To adapt overshot to insure alignment of tool with fish in large holes.

MILLING GUIDES: To remove burrs from tool joints or drill collars and to trim ragged pipe.

Bowen Releasing and Circulating Overshots are also made in Multiple Bowl assemblies for two and three sizes of fish. *A Bowen Overshot that can engage and pack off the drilling string at any point of failure should be on every rig floor before drilling is undertaken.*

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FIGURE 1—Thirty-six drilling rigs, largest number in any one Mexico area, are being operated at Poza Rica.

Mexico Spurring Oil Operations To Fill Part of the 'Suez Slack'

Pemex schedules completion of 410 wells for another record. Program is highlighted by first offshore drilling plans.

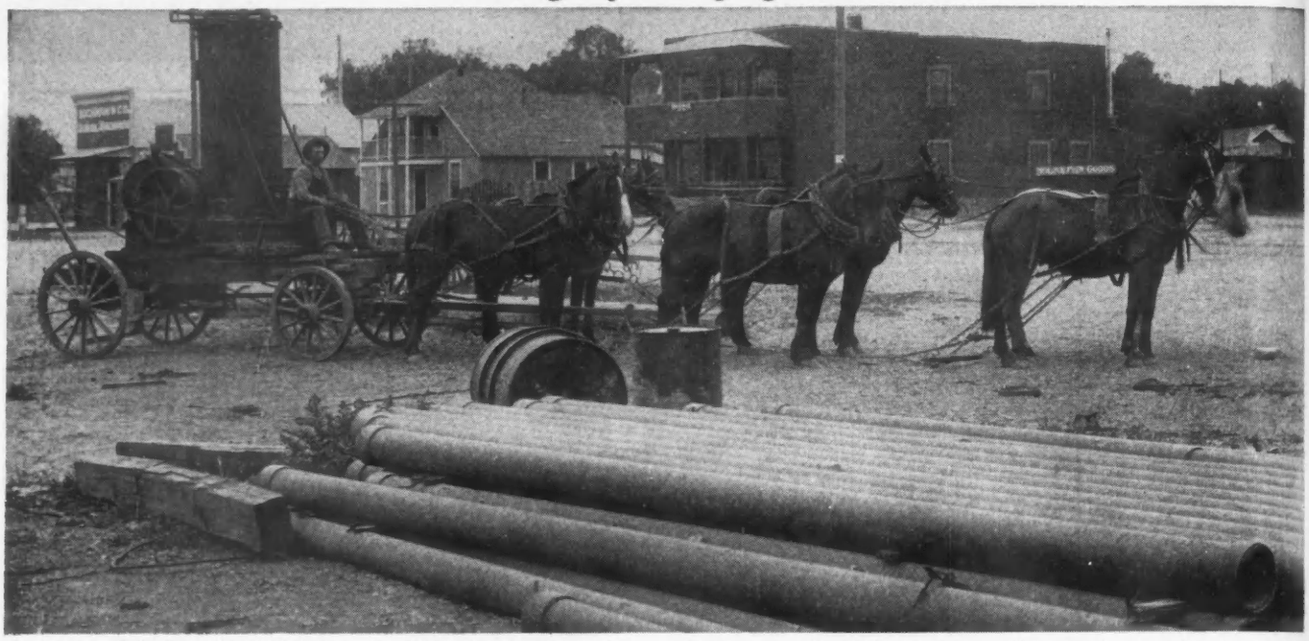
RISING INTERNAL consumption and a favorable market for exports created by the Suez crisis have spurred Mexico to an ambitious production plan for 1957.

The drilling program, calling for 410 well completions, will exceed the all-time footage record set in 1955. The quota of 400 wells for 1956 probably was surpassed, since 365 wells had been completed by Nov. 30.

Mexico's first offshore drilling is scheduled to begin at Laguna de Tamiahua, south of Tampico, in an area which is part of the New Golden Lane producing section. The operation will be conducted by a private contractor, Sharmex, S.A., which has a percentage arrangement with Petroleos Mexicanos, the government oil monopoly.

Of the 410 wells to be completed during the year (see Table 1), 348 will be drilled by Pemex and 62 by

YOUNGSTOWN meets the challenge of changing conditions



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private contractors who work with Pemex under a percentage arrangement.

The private companies are:

1. Compañía Independiente Mexico Americana (CIMA), whose contracts cover territories in Xicalongo, Campeche and San Javier, Nuevo Leon. In addition, the company holds a contract for offshore drilling near Coatzcoalcos, on the gulf, but no immediate action on this contract is planned.

2. Sharmex, S. A. de C. V., which is drilling in the Old Golden Lane area, including offshore operations in the Laguna de Tamiahua, south of Tampico.

3. E. W. Pauley, who holds a contract for the Reynosa area.

4. Isthmus Development Co., whose operating area includes territories near Ixhuatlan and Nuevo Teapa, in the Isthmus region.

Other private contractors, who operate on a straight fee basis, are:

1. Compañía Perforadora Latina S. A., which operates in Poza Rica.

2. Compañía Perforadora del Golfo S. A., also a Poza Rica operator.

3. Petroleo y sus Derivados S. A., which operates in Tampico Norte.

Petroleos Mexicanos has received 20 new drilling rigs, bringing its total to 110 at the close of 1956. At the end of 1955, Pemex had 88 rigs in the field (see Table 2).

Pemex' 1956 operational pace was mirrored in its new-field discovery rate. Twenty new oil fields were discovered during 1956 (see Table 3) as compared to 15 during the previous year. The new discoveries of major importance were:

- San Andrés, Vera Cruz Veracruz—a big producer.
- Matamoros, Tamaulipas—opens up a new gas producing region.
- La Tinta, Tamaulipas—scheduled for rapid development because of shallowness of field. The oil discovery was made at less than 800 feet.
- San Pablo and Mirador in central Veracruz, and Chilapilla, Tabasco—open up new producing areas.

Mexico's increase in production is keeping pace with rising domestic requirements which, of course, is the industry's chief aim. The nation's major problem, however, is the need for imports of refined products due to a lack of refining capacity and inadequate transportation facilities between refineries and centers of consumption. Imports for 1956 have been put at slightly more than 15 million barrels—a heavy dollar drain on Mexico's vulnerable balance of payments.

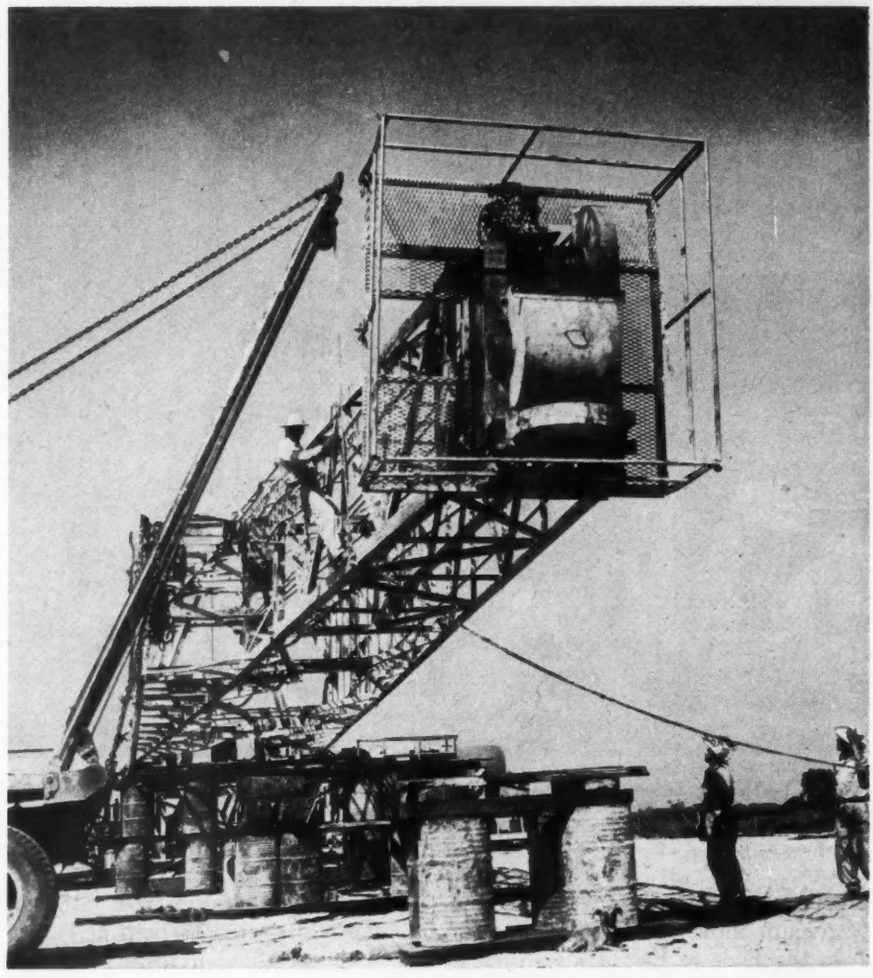


FIGURE 2—This jackknife drilling rig is being erected on a new well location in Tabasco States Jose Colomo oil field.

Construction of new refineries and pipe lines to solve this problem is the No. 1 item on Pemex' agenda. Although considerable progress has been achieved in the past several years, much remains to be done.

Reason for the delay is lack of investment capital, and that can be attributed directly to Pemex' price policy. Low prices for kerosine and fuel oil, chief sources of energy in coal-less and arid Mexico, and for gasoline, in effect, subsidize the na-

TABLE 2

Reynosa and Southern Zone Account for Major Part of Increase in Mexico's Drilling Rigs in Operation

LOCATION	Number of Rigs End of 1956	Number of Rigs End of 1955	Amount of Increase
Reynosa	21	12	9
Tampico	12	10	2
Poza Rica	36	34	2
Vera Cruz	10	8	2
Southern Zone	30	24	6
Baja California	1	..	1
Total	110	88	22

TABLE 1

15% of Mexico's 1957 Wells Will Be Drilled By Private Contractors

LOCATION	Exploratory	Development	Total	To be Drilled By: Pemex	To be Drilled By: Private Contractors
Reynosa	22	35	57	51	6
Tampico Norte	8	23	31	23	8
Tampico Sur (Old Golden Lane)	12	10	22	19	3
Poza Rica	13	120	133	88	45
Angostura	20	24	44	44	..
Southern Zone	24	99	123	123	..
Total	99	311	410	348	62

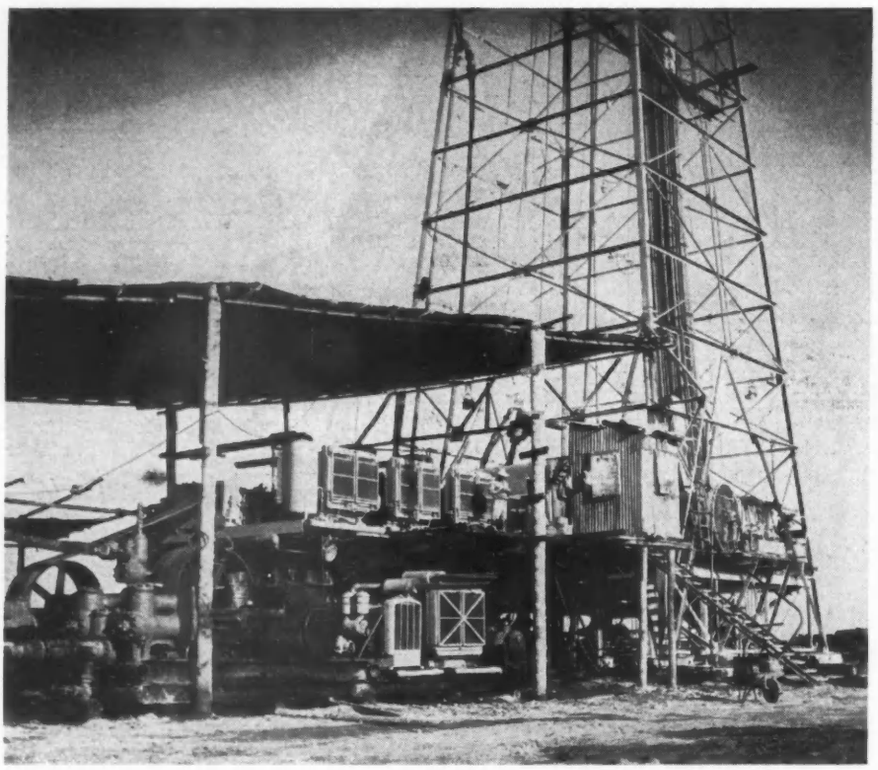


FIGURE 3—This rig, shown during a round trip operation, is one of the 21 drilling rigs operating in Reynosa.

tional economy at the expense of the petroleum industry.

In the Federal District, kerosine is sold for about four and a half cents (U. S.) per gallon and the standard grade of gasoline 18 cents.

The rising market for Mexico's crudes is expected to help in Pemex' determined efforts to solve the investment capital problem, and an increase in exports can be predicted for the immediate future. —**The End**

TABLE 3
These Are 18 of the 20 Fields Discovered in Mexico in 1956

LOCATION	NAME	DATE	TYPE OF FIELD
Agata, Veracruz	Agata 1	January 17	35-gravity oil
Tamaulipas, Tamps.	Tamaulipas 1	January 27	19-gravity oil
Mesa Cerrada, Ver.	Mesa Cerrada 102	February 25	21-gravity oil
Boca de Lima, Ver.	Boca de Lima 1	March 19	16-gravity oil
Las Canas, Ver.	Las Canas 2	April 6	23-gravity oil
Loma del Pozo, Ver.	Loma del Pozo 101	April 11	12-gravity oil
Guillermo Prieto, Tamps.	Guillermo Prieto 1	April 21	Natural gas
Gutierrez Zamora, Ver.	Gutierrez Zamora 2	May 29	20-gravity oil
Tecolutla, Ver.	Tecolutla 2	June 9	Oil
San Andres, Ver.	San Andres 1	June 19	Oil
Culebra, Tamps.	Culebra 1	August 24	Condensate
Matamoros, Tamps.	Matamoros 1	August 25	Natural gas
Canon Oriental, Tamps.	Canon Oriental 1	August 27	Condensate
Azucar, Tamps.	Azucar 1	September 27	Natural gas and condensate
San Pablo, Ver.	San Pablo 4	October 23	Natural gas and condensate
Chilapilla, Tab.	Chilapilla 1	October 31	Natural gas and condensate
Mirador, Central Veracruz	Mirador 1	October 31	Natural gas and condensate
La Tinta, Tamps.	La Tinta 1	November 10	Oil

TABLE 4
Here Is an Index to Mexico's Oil Production, Sales, Exports, and Imports From 1953 Through 1956

YEAR	Production Index (1938 = 100)	Daily Average Production (Barrels) (1938 = 106,351)	Annual Production (Millions of Barrels) (1938 = 38.5)	Domestic Sales (Millions of Barrels)	Exports (Millions of Barrels)	Imports (Millions of Barrels)
1953	191	203,000	72.5	55.5	15.4	8.92
1954	220	233,000	83.6	60.6	23.3	11.50
1955	235	250,000	89.4	63.8	25.8	14.98
1956	241	256,000	91.0*	68.0*	19.0†	15—plus

* Approximate. † As of October 31.

Trans-Europe p

IN HIS OFFICE in the old Wehrmacht barracks on the outskirts of Bonn, which houses the West German Economics Ministry, a government petroleum expert, explained:

"Last year, for the first time, petroleum consumption in the Federal Republic went over 10 million tons (70 million barrels). This was an increase of nearly 25 percent over 1954.

"Fuel oil consumption not only caught up with, but even slightly exceeded, gasoline consumption last year. Diesel oil consumption jumped 14 percent."

Chancellor Konrad Adenauer's petroleum expert predicted that by 1960 West Germany will be consuming a minimum of 20 million tons (140 million barrels) of crude oil annually, and by 1965 30 million tons (200 million barrels plus).

Across town, in the French section of the West German Foreign Office, on Koblenzerstrasse, Foreign Minister Heinrich von Brentano's Saar experts were engaged in a round of conferences with inland waterways technicians of the Federal Transport Ministry and representatives of Ruhr industry. Their subject: the Moselle river canal, a major proposal to give the iron and steel industry of Lorraine a water link to Ruhr coal and Dutch ports via the Rhine river.

In the same week the West German petroleum industry announced plans to build a pipe line linking the North Sea and the Ruhr river with Esso A. G., Hamburg, financing 40 percent of the cost.

These were the circumstances that spawned the trans-Europe pipe line project—the largest and most imaginative pipe line project yet conceived on the Continent.

This project provides for a pipe line reaching from the North Sea at Wilhelmshaven, the old German naval base, to Marseille, the French port on the Mediterranean sea. Lateral pipe lines would serve Switzerland, Luxemburg and Holland.

The trans-Europe pipe line proper would be laid between Marseille and

Pipe Line Economics Weighed

These are the factors involved:

- **Comparative costs of pipe line and proposed Moselle River Canal.**
- **Rapid rise in Western Europe's demand for oil and products.**

Leverkusen, in the Ruhr, where it would connect with the German petroleum companies' North Sea-Ruhr pipe line.

Tankers could unload Middle East crude for Western Europe at Marseilles, saving transportation costs over the long sea route around Spain and through the English Channel. Savings to the German petroleum industry are estimated at between 75 cents to $1 a ton.

The Marseille-Ruhr pipe line would cover 750 miles, require five years for construction and cost $112 million. The Ruhr-North Sea link would cost $40 million and require three years for construction.

Where is the tie-in between the Moselle canal and the proposed trans-Europe pipe line?

The Moselle canal is France's price for a final disposition of the Saar problem. Canalization of the Moselle River would give the French steel industry in Lorraine cheaper access to Ruhr coal. Lorraine's finished steel products could be shipped via water all the way to Rotterdam for export shipment.

France's feeling apparently is that if the steel producing capacity of the Saar is to be surrendered to West Germany, then France's own steel industry—in Lorraine—must be strengthened competitively to compensate for loss of the Saar.

Canalization of the Moselle River would require ten years and cost $150 million. The canal's upkeep is estimated at $10 million annually.

And since most of the Moselle River involved in the canal is inside Germany, the French, says one source, expect Germany to pay practically the entire bill.

Obviously, the Germans have little use for the Moselle River project. Ruhr industry is fighting it, and the Federal Transport Ministry is concerned over the loss of revenue to the state-owned Federal railways which would result from the Moselle River's canalization.

Chancellor Adenauer has had the Saar problem on his hands since he formed the West German government. The Saar dispute is a roadblock to Franco-German reconciliation and economic cooperation, a major goal of Adenauer's foreign policy. Furthermore, the prolonged Saar dispute has acted as a brake on European integration which Adenauer has pushed so hard.

Into this complicated—and heated—political situation, the German petroleum industry, with support of the Federal Economics Ministry, has stepped with blueprints for a trans-Europe pipe line.

The pipe line would be a boon to the entire Western European economy, and the pipe line's German proponents argue that France would snap up a chance to trade a Moselle canal for the pipe line, which would benefit the entire French economy instead of merely the Lorraine steel industry.

Aside from the fact that the pipe line would cost less than Moselle canalization ($112 million vs. $150 million), it has these additional advantages over the canal project:

1. Construction time for the pipe line would be half that required for the canal.

2. The pipe line would require negligible maintenance and upkeep compared with that required for a Moselle canal.

3. Cost of the pipe line could be amortized before the canal was constructed and put into operation.

Politically, the pipe line's proponents argue that it would help infuse energy into the European integration movement, which has been waning.

Some of Adenauer's top advisers feel that, in the current stage, European economic cooperation should be pitched on the technical level exemplified by the pipe line project. Integration projects like "Euratom," the proposed Western Europe-wide atomic energy pool, are, these advisers feel, premature and a handicap to the realization of more immediately practical cooperative undertakings.

West Germany's big petroleum companies—Standard Oil, Shell and British Petroleum—are pushing the trans-Europe pipe line project on an economics level.

At the present rate of industrial expansion, West Germany and other Western European countries are headed for a critical power shortage, proponents of the project say. The Ruhr coal industry is ailing, and the industry's doctors have just about given up hope for its recovery, they add. Despite planning by the Bonn government, nuclear energy still is a long way off for German industry.

Industry's concern is with the present; its answer to the energy shortage is increased use of petroleum. The same applies to the German economy in general. Heating, for example, is being shifted rapidly from coal to oil.

Increasing reliance on petroleum as the nation's primary energy source is reflected throughout West Europe, where petroleum consumption is at an all-time peak.

German Esso's participation in the North Sea-Ruhr pipe line project, for example, is being taken under the company's three-year expansion program costing $125 Million. Aside from participation in the pipe line, the biggest item in this program is the construction of a refinery near Leverkusen.

If the trans-Europe pipe line materializes, the North Sea-Ruhr pipe line will be used to supply crude oil discharge at Marseilles, France, to Germany's refineries at Hamburg. If not, the North Sea line will move oil in the opposite direction—from tankers discharging it at Wilhelmshaven, Germany, to refineries in the Ruhr.

—The End

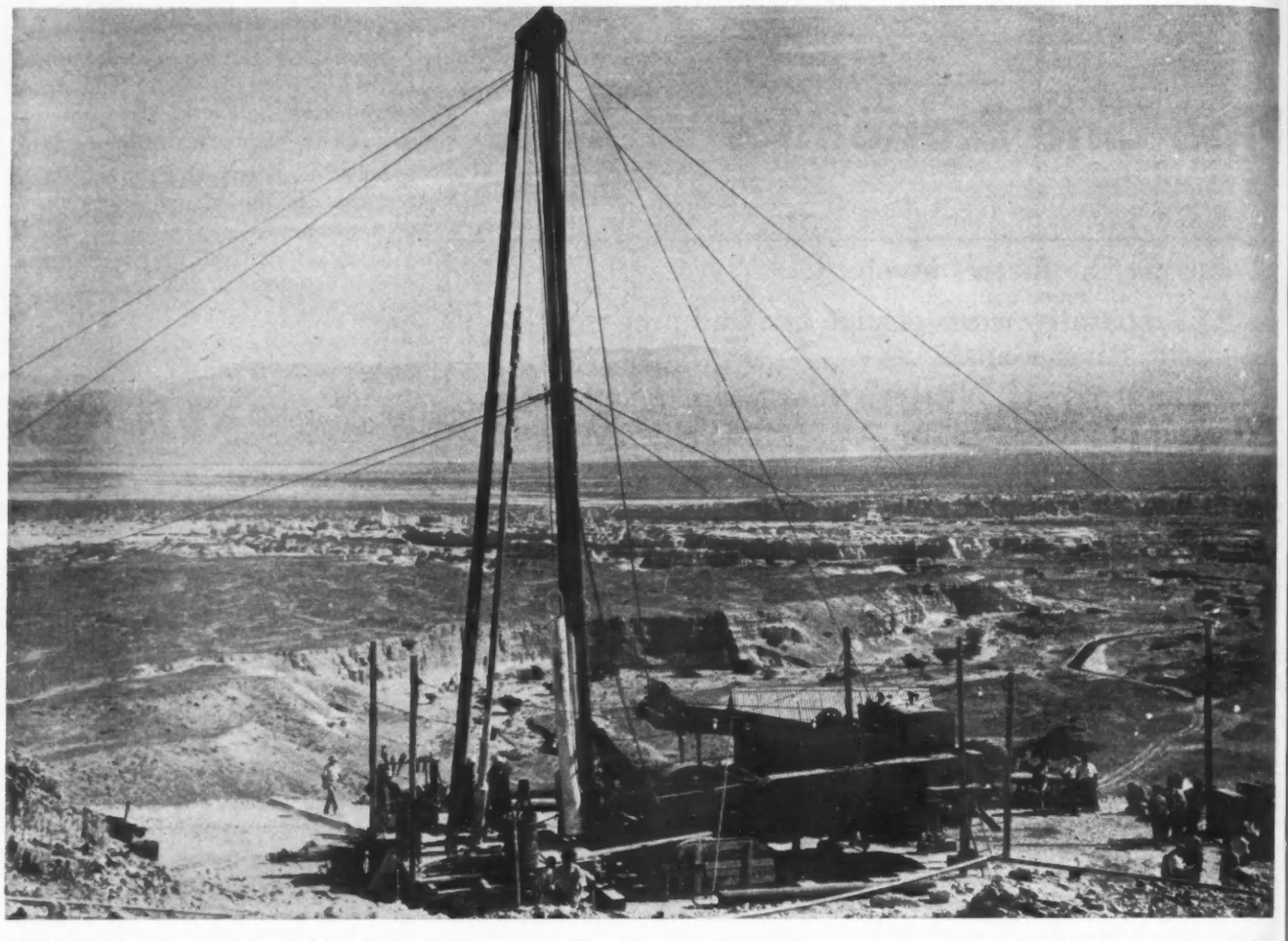


FIGURE 1—This cable tool rig is drilling in the Dead Sea area as Israel's exploration operations are stepped up to offset the stoppage of crude from the Middle East.

Israel Steps Up Drilling And Production Operations

Nation's single oil producing field scheduled to reach production level of 2100-2800 barrels daily this month.

Dislocation of oil supplies from the Middle East has prompted Israel to increase oil production and speed additional drilling operations in its only successful field to produce 2100 to 2800 barrels of oil daily by February.

While Israel's petroleum production still is small compared with its annual needs, every barrel produced domestically saves the country between $3 and $4 of its scant supply of hard currency. According to Dr. Walter R. Fehr, Swiss consulting geologist, Israel could easily become self-sufficient in petroleum within the next decade.

Oil was discovered in the Heletz field, 30 miles south of Tel Aviv, in September, 1955, by Israel Oil Prospectors Corporation, Ltd., and Lapidoth Israel Petroleum Corporation, Ltd., two Israeli companies which are jointly operating the license areas granted to each. Since then, eight other flowing wells have been drilled, six of which currently are in production.

The remaining three wells will be put into production as soon as the operators can obtain required steel tubing and other equipment to complete them. This became known recently in the first report since hostilities between Israel and Egypt began on October 29.

In addition, the oil companies are drilling five additional wells in Heletz, and are planning to drill at a sixth location there as soon as another rig becomes available. A well also is being drilled at Brur, southwest of Heletz, and a deep exploratory well is being drilled in the Dead Sea area, near the site of the Biblical city of Sodom.

Since the discovery of Israel's only oil, the report said, the companies have produced Heletz oil conservatively through small chokes lest a more rapid operation destroy the gas pressure. However, it was reported that with the onset of hostilities, the chance had to be taken of increasing the size of the chokes.

The initial experiment occurred at Heletz 1, the discovery well, which, on a $\frac{3}{16}$-inch choke, was producing 125 barrels of oil daily, with a top

pressure of 119 pounds per square inch. With the choke increased to one-quarter inch, the yield was 205 barrels a day, an increase of 64 percent. The top pressure dropped only to 111 pounds per square inch, which was considered safe.

The second well on which the choke-size was increased was Heletz 5, where the pressure was lower. On the 3/16-inch choke, it was producing an average of 125 barrels per day with a top pressure of 99 psi. With the choke increased to one-quarter of an inch, production rose to 190 barrels a day with a pressure drop to 88 psi.

The experiments proved so successful that field managers are planning to increase the choke size on the other producers, Heletz 2, 3, 11 and 12.

Because of the growing national need for oil, particularly in short supply since Soviet Russia cancelled its contract to supply Israel with 20 percent of its domestic needs, further development at Heletz is being accelerated.

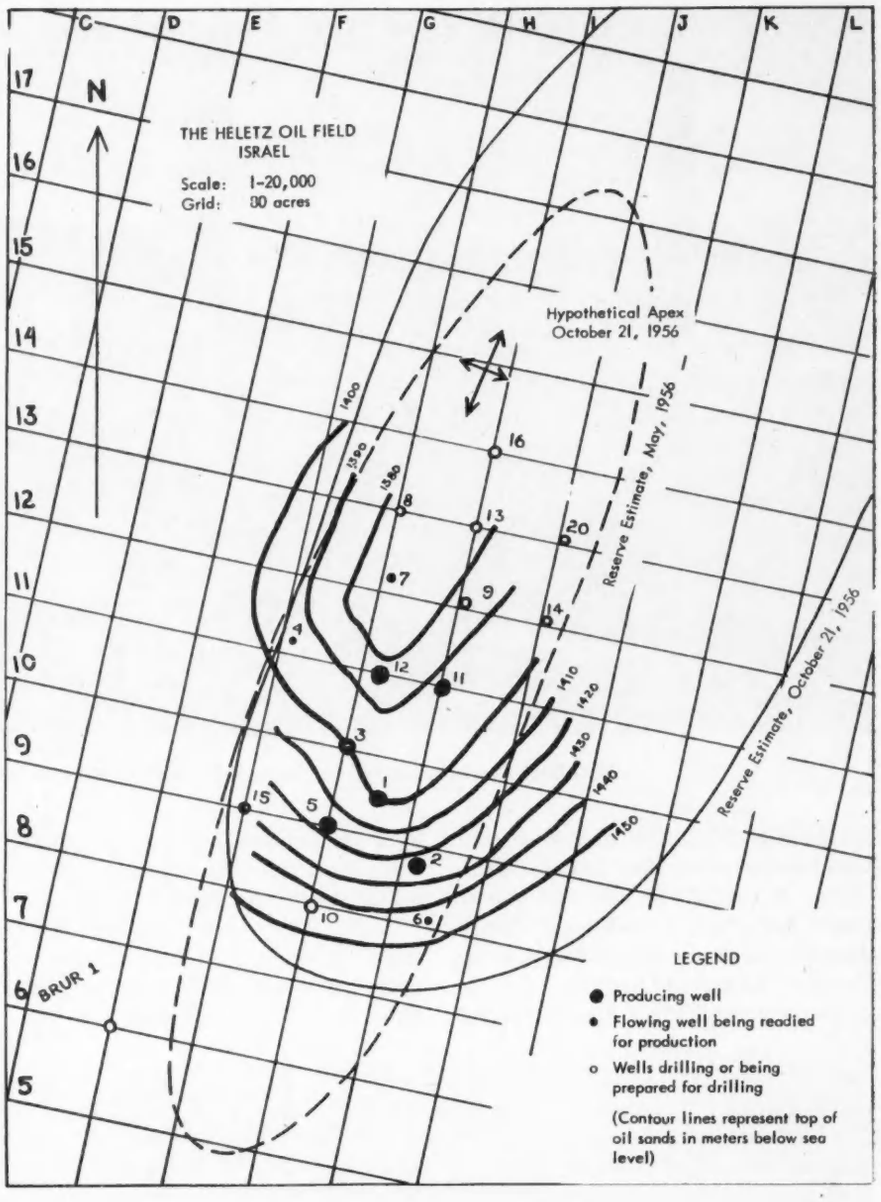
The companies own five drilling rigs which are at work and have rented two more from Water Works, Ltd., an Israeli company which drills deep water wells for irrigation and living purposes. The companies plan to lease an additional rig from Water Works, and are negotiating for at least two extra rigs from other oil companies which have decided to suspend Israel operations.

Thus, the companies expect to have 10 rigs working at Heletz and Brur, as well as the wildcat test in the Dead Sea region.

It appears that, barring an unfortunate complication, a minimum of 60 wells and perhaps as many as 100 will be producing before the Heletz field is entirely drilled up. Dr. Fehr feels that the field's reserves cannot be expected to be less than 10 million barrels and, in view of known geological and gravity data, may be in the order of 50 million barrels.

The field's productive area, which has been proved by consecutive offset wells, is slightly more than a mile long in the north-south direction and about 3500 feet in the east-west direction, making about 500 acres definitely classed as productive. All known geological data pointed to a larger field.

There is not less than 260 feet of effective oil column, with the summit of the structure yet to be found



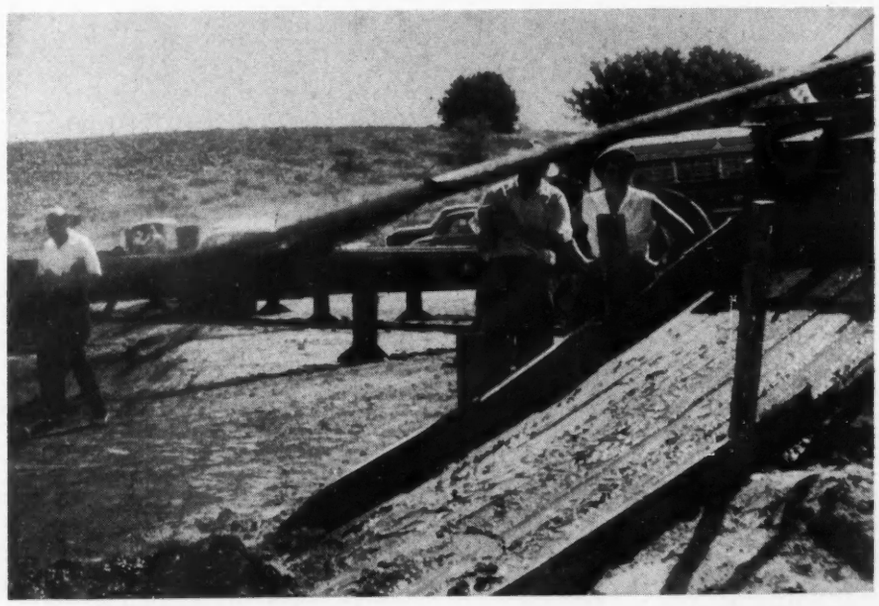


FIGURE 2—Heletz 11, located in Israel's single oil field, was brought in as a flowing well.

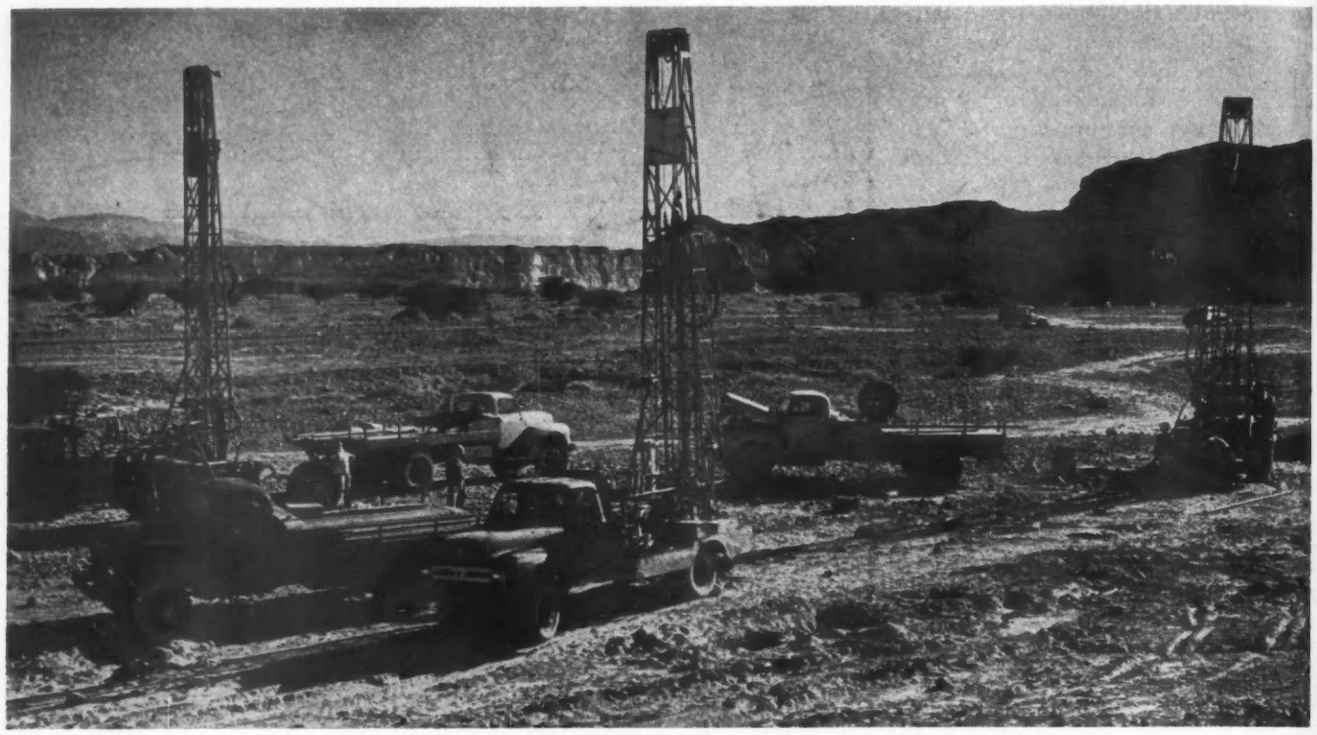


FIGURE 3—Seismic shot holes are being drilled by the Weismann Institute near Sodom.

by drilling. No salt water has been found even in the southernmost well, Heletz 6, which is 230 feet lower structurally on the producing horizon than Heletz 7, the highest well, completed at the end of October.

The western limit of the producing sand appears to have been defined. The crest of the structure is expected to lie still farther north.

A dry hole drilled at Negba, five miles to the northeast, encountered sand correlative with the producing sand at Heletz and 282 feet lower structurally than Heletz 7. Structure drilling at Negba has shown this dry hole to be about 165 feet lower than the Negba structural crest, so it may be that the present Heletz production is located at the extreme south end of a structure about five miles

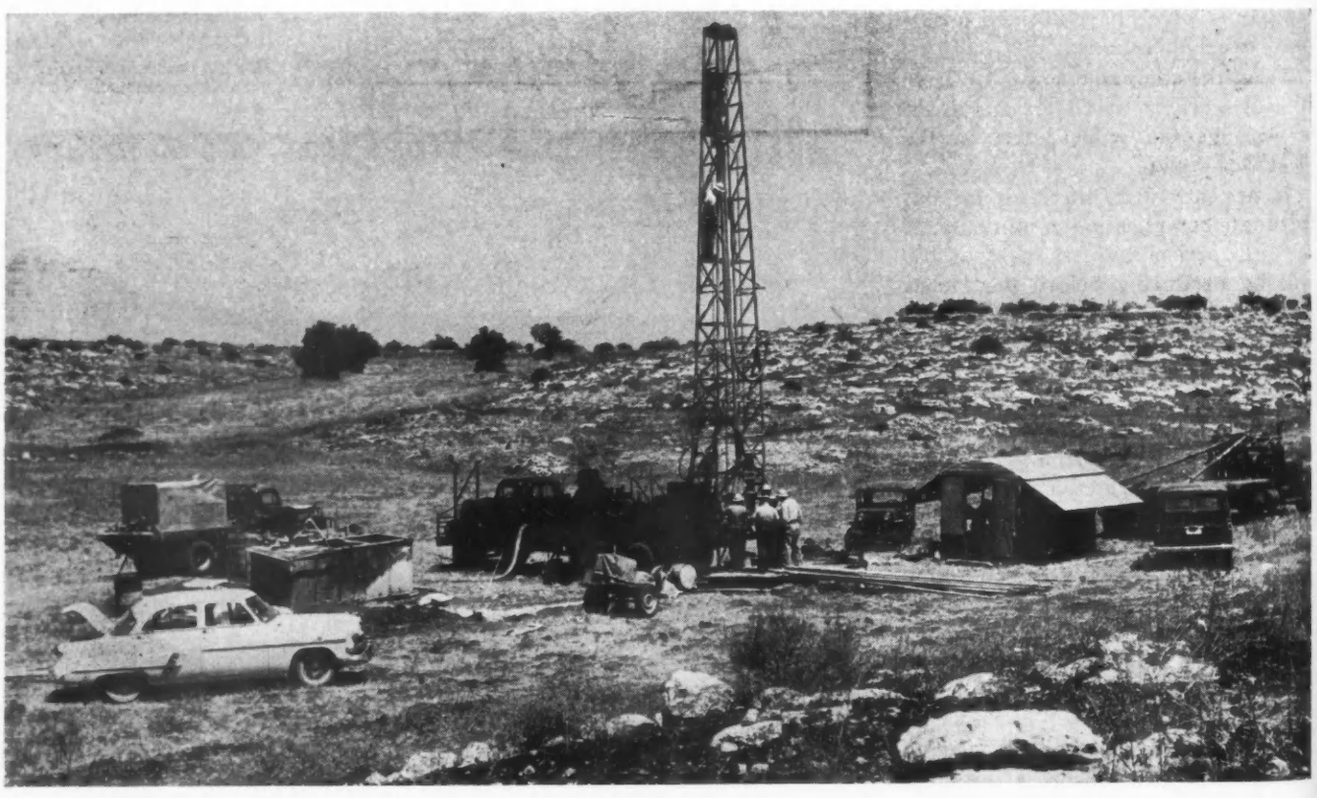


FIGURE 4—This core drilling operation near Heletz field is being conducted by Pan Israel and Israel Mediterranean.

long. Gravity data appear to confirm this. A series of four gravity maxima, trending slightly east of due north occur, according to Dr. Fehr's interpretation, from Beeri, 15 miles south of Heletz, to Negba. The crest of the Negba maximum lies about four miles north of current Heletz production.

A production MER of 125 barrels daily for each well drilled in the field had been established. The pay zone apparently thickens eastward and wedges out westward. Heletz 4, the westernmost well completed yet, encountered only about three feet of sand, according to the contact electric log. Nevertheless, it came in as a good producer, emphasizing the excellent permeability of the sand. Field spacing has been increased from the originally-intended 40 acres to 80-acre spacing.

In addition to being permeable, the sands are highly saturated, not too deep and the structure as is known thus far probably is a large one. And no salt water has been found.

However, the producing sand may be erratic in its development, and stratigraphy probably will be at least as important a factor as structure when ultimate reserves of the field can be calculated. The pressures are normal at best, and a pronounced pressure drop could adversely affect production.

Greater reservoir energy may be encountered as drilling reaches the crest of the structure. It is true that a deep test, located at or near the crest of the structure when it has been determined, might reveal deeper pays which have not been evaluated.

Seven-inch casing usually is run in Heletz wells, a factor which would allow deeper drilling later if deeper pays were found.

Lost circulation is a problem, particularly in the Judean limestone section (Cretaceous) at about 3500 feet, where cavernous conditions are apt to be encountered suddenly.

Following the Heletz discovery, a five-mile, seven-inch crude pipe line was built to the railhead at Ashkelon for shipment of crude to the Haifa refinery by rail as soon as loading facilities were completed. Tank trucks were being used. Crude storage facilities at Heletz can accommodate up to 14,000 barrels. To increase transportation capacity, a new pipe line may be built to the nearby Mediterranean coast at Sukrer. From there, coastal tankers would take crude to the Consolidated refinery at Haifa.

Other wildcats in Israel, including those elsewhere along the Mediterranean coastal plain, all have been dry. But exploration in Israel still is in an early stage and it may be that very little acreage has been condemned. The Beeri dry hole, for instance, which penetrated a thick Jurasssic section in the almost 12,000 feet of hole drilled, was located on a big gravity maximum. But it now appears from correlation of the log of this well that the sand productive at Heletz may have been faulted out at Beeri.

One of the factors that has contributed to the lower price of Middle East oil has been the effectiveness of gravity exploration, among the cheapest of geophysical exploration techniques. Gravity work has been particularly effective in Saudi Arabia and in the Suez graben in Egypt.

Now, it appears from structure and wildcat drilling that gravity maxima in Israel often indicate a big anticline. And if the trend of gravity anomalies extending northward from Beeri, Saad, Hesi, and Negba lives up to expectations, Israel could become self-sufficient oil-wise in ten years. Current domestic requirements are about 28,000 barrels a day.

—The End

Creole president tells WORLD OIL:

Venezuela Can Supply Only Small Part of Europe's Needs

Can Venezuela furnish "stop gap" oil for Europe in the event the Middle East supplies are cut off? These and other questions were answered by H. W. Haight, president of Creole Petroleum Corp., Venezuela, during a recent visit he made to Tulsa.

By ANTHONY GIBBON
WORLD OIL Staff

Q. Can Venezuelan production supply the needs of Western Europe in the event Middle East supplies are cut off?

A. Only a small amount of the oil which Europe is demanding as a result of the Middle East crisis can come from Venezuela. Venezuelan fields are already being produced at a maximum efficiency rate and it "will be very difficult" to increase output more than already programmed several months ago. Venezuela cannot up "immediately" its production from approximately 2.5 million barrels a day to 3.5 million barrels to take care of Europe.

Q. What would be the effect on Venezuelan fields if production valves are opened wide?

A. Venezuela could increase its production a million or more barrels a day, but it would mean ruining the fields, and neither the oil companies nor the government would likely do that. Venezuela already is producing at the maximum efficiency rate.

Continued on next page.

Q. Is this the only problem to increasing production?

A. There are other problems involved in refining. For instance, most of the companies operating in Venezuela sell on long-term contract and the crude's destination was determined before the Suez Canal was blocked.

Creole has done one thing, however, to get more crude to meet the rising demand from Europe.

The firm has reduced refinery runs by about 30,000 barrels a day in Venezuela. However, this move was possible because of the high stocks of gasoline and refined products.

We are in the same boat there as in the U. S. Our stocks are too high.

Q. How about the supply picture: Does this affect efforts to increase production?

A. Venezuelan production can be increased only at the programmed rate because of the limiting factor of pipe supplies and other materials. The increase will be about 300,000 barrels daily by the end of 1957, bringing the output to about 2.8 million barrels.

Q. What is the feeling in Venezuela as regards limiting oil imports into the U. S?

A. The Venezuelan government and the oil companies there are desirous of preventing U. S. legislation against imports and are cooperating with import quotas.

Venezuela has always been friendly to the U. S., and is vitally concerned with the import picture in the U. S. since approximately 800,000 barrels daily, or about 38 percent of the output, goes to the U. S.

Oil is the basis of Venezuela's economy and a big curb on imports to the U. S., like a 20 percent cut, would bring on a depression and affect the whole country. As a result, the Venezuelans get bothered whenever the import question comes up in Congress.

Although exports to the U. S. are vital, Venezuela does not expect to be allowed "to flood the U. S. with foreign oil."

They just don't want any cutback. They were very well pleased with Flemming's recommendation (that Venezuelan and Canadian oil be exempt from quotas.)

Q. Returning to the Middle East crisis, what effect has it had on Venezuelan operations?

A. The main impact so far on Venezuela of the Middle East crisis has been an increased demand for heavy crude oil. However, the heavy crude demand has been constantly larger in Venezuela and the demand has merely become stronger. As a result, there is a shortage of the crude there and the prospects for increasing output is dim because of lack of transmission lines.

Creole has one concession that produces heavy crude, but we will not be able to get pipe shipments for a line until 1959. Demand for heavy fuel oil, as reported in the Mid-Continent and Gulf Coast areas, also is high in Venezuela, but any increase in exports would have to come from stocks. It remains to be seen whether this fuel oil will be diverted to Europe. If all of it were to go to the continent, there would be a serious shortage in the United States.

Q. Are there any currency exchange problems involved in the current situation so far as Venezuela is concerned?

A. There may be difficulties over shipping oil from Venezuela to Europe because of a shortage of dollars by the European countries. The Middle East is "sterling oil," and they (Britain and France) don't have too many dollars to buy oil in Venezuela or the U. S. One possibility is that the Middle East oil shipments to the U. S. will be diverted to Europe because they can be purchased in sterling.

—The End

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Act now. The supply is limited.

Sunset International Test Is Oil and Gas Producer

Sunset International Petroleum Corporation's initial venture in Canadian oil exploration resulted in an oil and gas producer near Edmonton, Alta. On formation tests, the well flowed 38 gravity crude and natural gas at a daily rate of up to 1,250,000 cubic feet.

Casing has been set and cemented at 4100 feet and a thorough production test was scheduled.

The well was drilled in a joint venture by Sunset, Terminal Oil Co., and Douglas Oil Co., Los Angeles, and Brinkerhoff Drilling Co., Calgary, Alta. The latter is operator, and each of the four holds a 25 percent interest in the venture.

Pemex Investments During 1957 to Hit $32 Million

Investments by Petroleos Mexicanos, government oil monopoly, for the current year will total $32 million. To fulfill its program of drilling and exploration; refinery, pipe line and storage construction; and purchase of equipment, tank cars and ships, Pemex will depend primarily on local capital and internal credit, although some assistance is expected from sources outside the country.

In addition to its drilling plans, major projects outlined for 1957 include:

- Purchase of 40 drilling rigs, 100 rail tank cars and three tankers for the Pemex fleet.
- Installation of a new cracking plant at the "18 de Marzo" refinery.
- Completion of a drydock and shipyard at San Juan de Ulúa.
- Construction of a refinery at Ciudad Madero.
- Expansion and modernization of Arbol Grande refinery.
- A new lubricants refinery in Minatitlan.
- Start of construction of a new Poza Rica refinery.
- Additional plant for the lubricants refinery at Salamanca.
- Pipe line expansion and improvement of the lines between Tampico and Monterrey, Xacotla-Alamos, and the natural gas lines out of Reynosa, Poza Rica and Ciudad Pemex.

COMMERCIAL air transportation is one of the fastest-growing industries in America. But it should never be forgotten that with almost every new stride this industry has taken, the petroleum industry has had to be one jump ahead . . . has had to be ready with the lubricants and fuels to fit the job. We of The Texas Company are proud that our association with this vital industry has been such a long and successful one. In fact . . .

For more than 20 years, more scheduled revenue airline miles in the U. S. have been flown with Texaco Aircraft Engine Oil than with all other brands combined.

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TEXACO

Right down the petroleum production line...

Macks HANDLE THE IMPORTANT JOBS

Like every other industry with challenging, big-time hauling jobs to do, the petroleum industry depends on its Macks . . . all the way from drilling wells to service station deliveries. Petroleum producers have found through long experience that their equipment travels at the lowest cost per mile . . . their products move at the lowest cost per gallon . . . in the Mack made for the job.

Whatever you have to haul, wherever you want to haul it, if it's an important job, it's a Mack-sized job. Users agree that no other heavy-duty truck is engineered to the tough, demanding jobs with the same thoroughness and precision as Macks . . . no other truck can be counted on for the same high-volume, high-efficiency hauling, year after year.

Want proof? Ask operators of Macks. Any Mack Branch or Distributor will gladly give you names.

FACTS ON MACKS

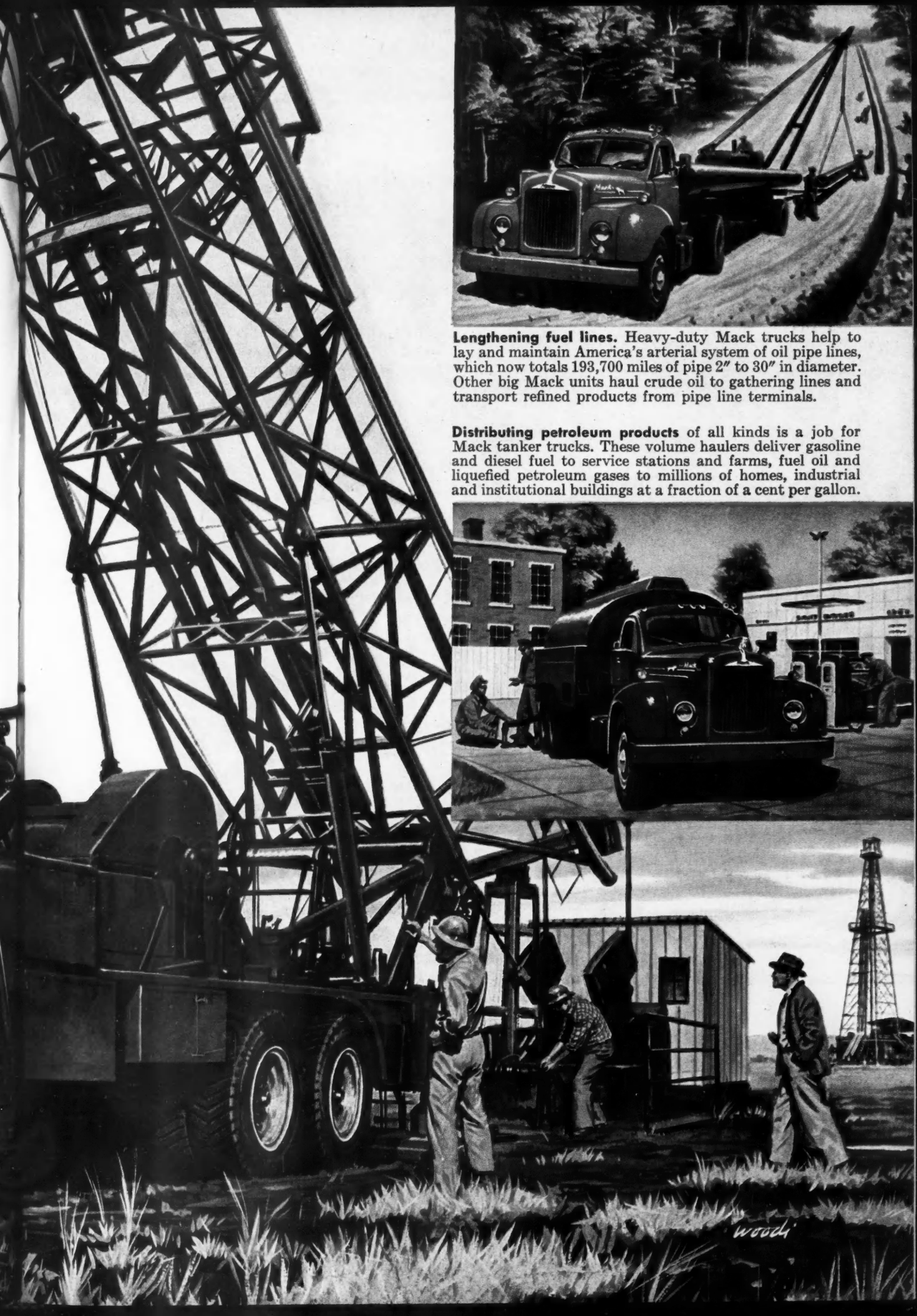
Did you know that Mack makes more of its component parts than any other truck manufacturer? Engines—both diesel and gasoline—frames, transmissions, gears, axles, cabs . . . all are products of the most precise mass production techniques in the automotive industry. This is one good reason why the familiar expression "Built like a Mack" symbolizes the utmost in strength and endurance.

Mack

FIRST NAME FOR TRUCKS

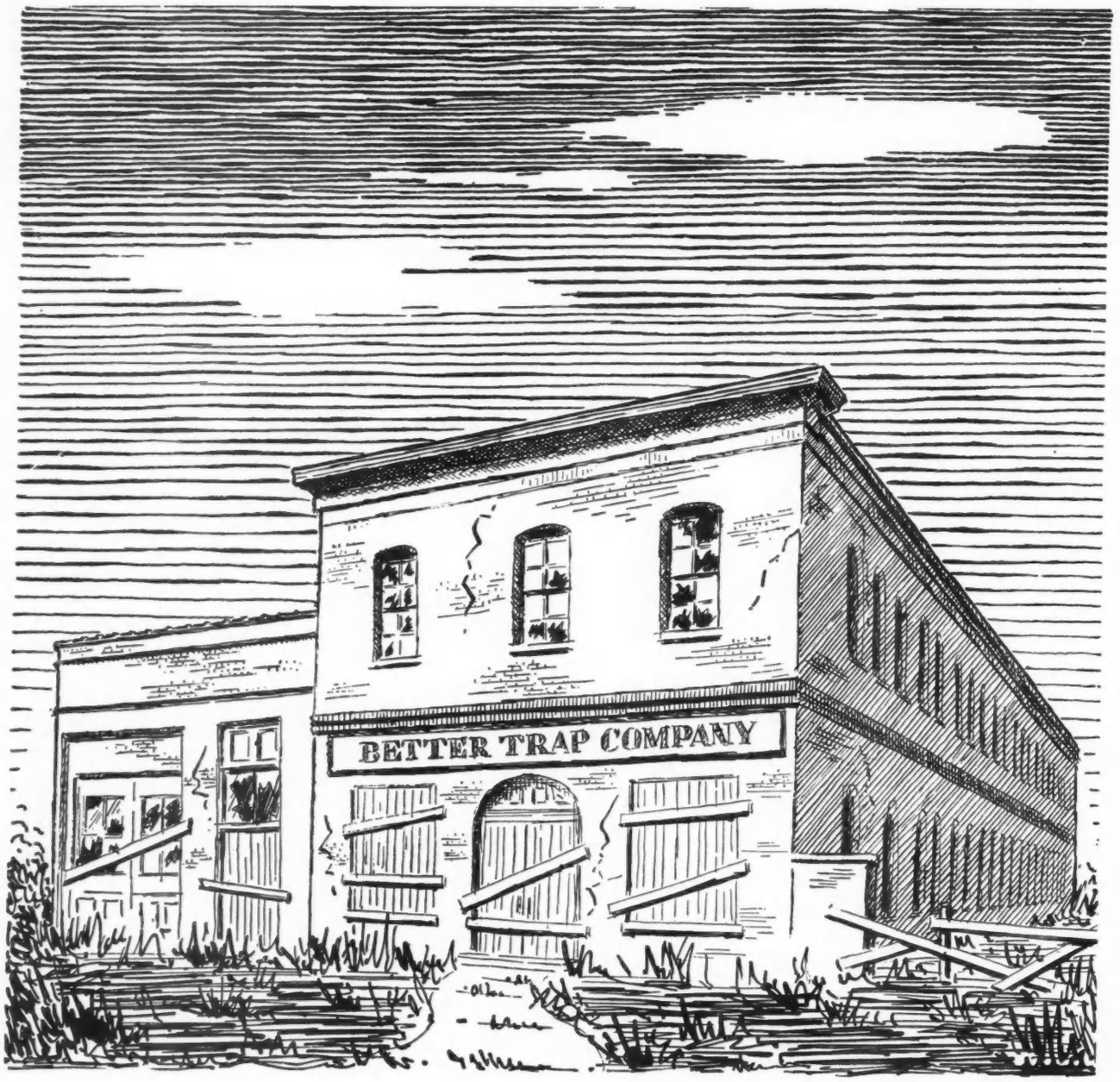
Mack Trucks, Inc., Plainfield, New Jersey.
In Canada: Mack Trucks of Canada, Ltd.

"Have trucks, will travel" applies to today's fast-moving drilling crews. Large Mack diesels haul derricks and drilling equipment weighing as much as 100 tons to field sites, usually many miles from paved roads. Here trucks stay till the job is finished, often furnishing engine power for pumping or drilling.



Lengthening fuel lines. Heavy-duty Mack trucks help to lay and maintain America's arterial system of oil pipe lines, which now totals 193,700 miles of pipe 2″ to 30″ in diameter. Other big Mack units haul crude oil to gathering lines and transport refined products from pipe line terminals.

Distributing petroleum products of all kinds is a job for Mack tanker trucks. These volume haulers deliver gasoline and diesel fuel to service stations and farms, fuel oil and liquefied petroleum gases to millions of homes, industrial and institutional buildings at a fraction of a cent per gallon.



MOUSETRAP, STEAM TRAP, SEWER TRAP

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. . . the world *won't* beat a path to the door of the man who builds a better one *and then doesn't advertise it* so that people will know about his product, know where it can be bought and how much it costs.

Advertising benefits the buyer, too. It tells you the product story, makes it easy for you to buy. Even more important to you, advertising leads to mass production and volume sales . . . which means lower costs and lower prices.

Yes, "Advertising Benefits You" . . . 'specially business-paper advertising.

WORLD OIL

Costa Rica to Seek Company Concession Bids

Costa Rica will ask oil companies for bids for exploration and development concessions in two areas of the country. One is in the province of Heridia and the other in the province of Puntarenas bordering the Pacific Ocean.

Although Costa Rica is drafting a petroleum law, officials of the Division of Industries, Ministry of Agriculture, which is in charge of oil concessions, stated that the two concessions will be granted prior to the enactment of such a law. They stated that under the circumstances, any agreement reached with oil companies for rights will be on the basis of a contractual arrangement subject to approval by the Legislative Assembly. They stated late in October that nine American oil companies have expressed an interest in the concessions.

At present, Union Oil of California is the only company holding exploration and development rights for petroleum in Costa Rica. Union located oil deposits in the province of Limon this year near the Panama border. However, the deposits have not yet been determined commercially feasible. Union is reported to be one of the American oil companies that is interested in the new concessions that are to be offered.

Saskatchewan Government Publishes Contour Maps

Two maps of Saskatchewan, showing gravity contour lines, have been compiled by the provincial Department of Mineral Resources and are available from the department.

One map deals with the northern part of the province and the other is of the southern area. Each has been compiled from gravity data submitted to the department by crown permit holders in compliance with regulations under the Minerals Resources Act. Only that information that has now attained non-confidential status is included.

These are the first maps of this kind to be issued by the department and revised editions will be published when further information is available.

France Sets Algeria Area Payoff At 150 Million Barrels of Oil

Will France find 150 million barrels of oil in a remote area of Algeria? At least that much must be found to make development and shipment pay off, French companies figure.

About 80 miles from an Algerian Sahara desert oasis, boasting 3000 inhabitants and located about 500 miles southeast of Algiers, production of about 2000 barrels a day of light oil was found at slightly more than 11,000 feet. There was no uncertainty about the thickness of the Ouargla well deposit but doubt was expressed concerning its extent since the formation had not been determined.

Another factor which has curbed the enthusiasm of drillers for the National Society for Prospection and Study of Petroleum in Algeria (SNREPAL) was the remote location. With Mediterranean ports approximately 500 miles distant, the new well is 400 miles northwest of an earlier discovery at Edjele, near the Algerian-Libyan border.

Unless crude reserves of about 150 million barrels can be established, one report indicated that producing any lesser amount would be uneconomic.

The production of the Ouargla discovery is approximately the same as the production discovered about 150 miles from Algiers earlier by Compagnie Francaise des Petroles d'Algerie, in which the state owns 35 percent interest. The CFPA well found oil in Triassic sandstone at 8500 feet.

In French West Africa, results have been more reassuring. There, oil has been discovered at 4000 feet in dolomite, which led the prospectors, Societe des Petroles d'Afrique Equatoriale Francaise, also a state controlled company, to put five rigs in operation.

While the volume of production is not large—ranging between 600,000 barrels and 800,000 barrels annually, transportation is less of a problem. Storage facilities have been installed at Cap-Lopez.

Guatemala Concession Is Granted to SoCal

Standard Oil Company of California reportedly has been awarded a 66,717-acre concession in Guatemala. SoCal's concession lies along the Caribbean coast in northern Izabal province.

Holding interests in the SoCal concession are Standard Oil Company (Ohio), The Ohio Oil Company, Bandini Petroleum Co., Texas Petroleum Co., Signal Oil and Gas Co., and Petroleos Guatemaltecos. Total acreage under concession in Guatemala amounts to 1,452,175 acres.

Earlier, Continental Oil Company of Guatemala was granted exploration rights on 394,000 acres. This acreage was to be combined with earlier concessions to The Ohio Oil Company and Amerada Petroleum Corporation and explored as a unit.

On October 29, Petroleos Atlas Guatemala S. A. was assigned exploration rights on about 250,000 acres, and Guatemala Atlantic Corporation acquired about 500,000 acres, all in Northern Peten.

Esso Standard of Guatemala Inc., also was scheduled to receive a northern Peten grant of more than 300,000 acres, located between Continental and Shell permits. These grants run to total number of Guatemalan concessions announced so far to 14.

German Firms Get Permits In Syria and Northern Saar

By a decree of the Syrian government, Societe des Petroles Concordia of Damascus, an affiliate of the Deutsche Erdoel AG., has been granted an exploratory permit covering about 5800 square miles in northeastern Syria.

It is believed that in this part of the country the stratigraphic and structural conditions are similar to those in neighboring Iraq.

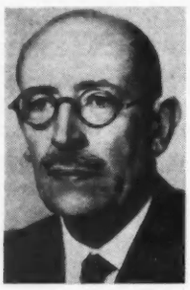
Meanwhile, after concessions were granted for a narrow area in the northern part of the Saar Territory, exploration concessions covering all those parts of the Saar area which are likely oil prospects have been granted to Deutsche Erdoel AG., Deutsche Schachtbau- und Tiefbohrgesellschaft mbH., Mobil Oil AG and Wintershall AG.

In various mines in the Saar territory, particularly in the Frankenholz mine near Neunkirchen, oil traces previously have been found in the Carboniferous.

What's Happening

AMONG WORLD OIL MEN

Robert Gillespie



E. H. O. Elkington

ROBERT GILLESPIE, C. B. E., has been appointed a managing director of The British Petroleum Company Limited. He fills a vacancy caused by the retirement from the board of directors of E. H. O. ELKINGTON.

Gillespie joined the British Tanker Company (now the BP Tanker Company), shipping organization of British Petroleum, in 1922. He was appointed general manager of the British Tanker Company in 1944, becoming a director in 1946 and managing director in 1950. In the New Year Honors in 1951 Gillespie was created a Commander of the British Empire (C.B.E.).

Elkington joined British Petroleum in 1921 and from 1929 to 1937 was general manager in Iran and Iraq. He was appointed a managing director in 1947.

J. HOUSTON JACKSON, general manager of the BP Tanker Company has been appointed a director of that company. He retains the general managership.

•

WILBURN T. ASKEW has been elected president of Sun Oil Company, Ltd., of Canada, succeeding JOSEPH N. PEW, JR., chairman of the parent concern, Sun Oil Company. Askew will be headquartered at the Canadian firm's offices in Toronto. He was until recently manager of the Marcus Hook, Penn., refinery. Askew is thus the first resident president of the Canadian firm, after 25 years with the parent firm.

•

W. C. SUMMY, former assistant division production superintendent in Sinclair Oil and Gas Company's Houston office, has been transferred to Sinclair Oil and Refining Company as superintendent of its Santa Barbara, Venezuela, operations.

•

WALTER G. WELSCH has been named manager of Texaco S. A. (Mexico), succeeding K. B. NIVEN, retired. Welsch was previously assistant manager.

•

ROBERT J. BELKNAP has been named managing director of Standard-Vacuum Oil Company (East Africa) Ltd. at Nairobi, succeeding L. H. TREMAINE, retired. Belknap started with Stanvac in 1938 as district sales manager in Calcutta, and most recently was general manager of Standard-Vacuum Sales Company in Indonesia. JOHN R. KENDALL will replace Belknap in his previous post.

•

DAHL M. DUFF has been transferred to the staff of the Middle East advisor of Standard Oil Company (New Jersey) in New York City. Duff's former post was in the Public Relations department.

•

Rear Admiral CARL G. DRESCHER has been named assistant director of foreign operations by Sinclair Oil Corporation. A Naval Academy graduate, Adm. Drescher has served the Navy in several petroleum posts, and was the Navy's first director of the rotated position of ASPPA. He will now be located in Sinclair's New York office, helping direct the company's foreign exploration, production, supply and distribution activities.

Carl G. Drescher

•

W. C. LANE has been appointed manager of Standard Oil Company of California's Foreign Trade department, succeeding J. E. BLACK, who has retired.

Lane, who had been assistant manager of the department since 1946, has been with Standard for nearly 30 years. A native of Seattle, he attended the University of Washington and joined the company as a service station salesman.

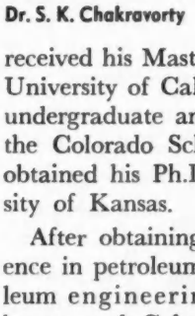
During his career, Lane has served in various sales capacities on the West Coast and at one time headed the Company's New York office. During World War II he served with the U. S. Navy.

A resident of San Mateo, he is a member of the Stock Exchange Club of San Francisco and the Peninsula Golf and Country Club.

Black, who served nearly 45 years with Standard before retiring, was appointed manager of the Foreign Trade department in 1931. His early career included assignments in clerical and sales capacities, and service with the Navy in World War I.

•

DR. S. K. CHAKRAVORTY has been appointed production manager of New Superior Oils of Canada Limited, succeeding B. H. COREY, who recently resigned.



Dr. S. K. Chakravorty

Dr. Chakravorty has served as chief petroleum engineer for New Superior Oils of Canada Limited since December, 1953. He received his Master's Degree from the University of Calcutta, completed his undergraduate and graduate work at the Colorado School of Mines and obtained his Ph.D. from the University of Kansas.

After obtaining extensive experience in petroleum geology and petroleum engineering in Kansas, Oklahoma, and Colorado, he joined the Saskatchewan government in June, 1951, as supervisor of petroleum engineering and geology, being promoted later to the position of chief oil and gas conservation officer. He remained in that position until his appointment with New Superior in 1953.

Now! Enter against pressure safely... *at any time!*

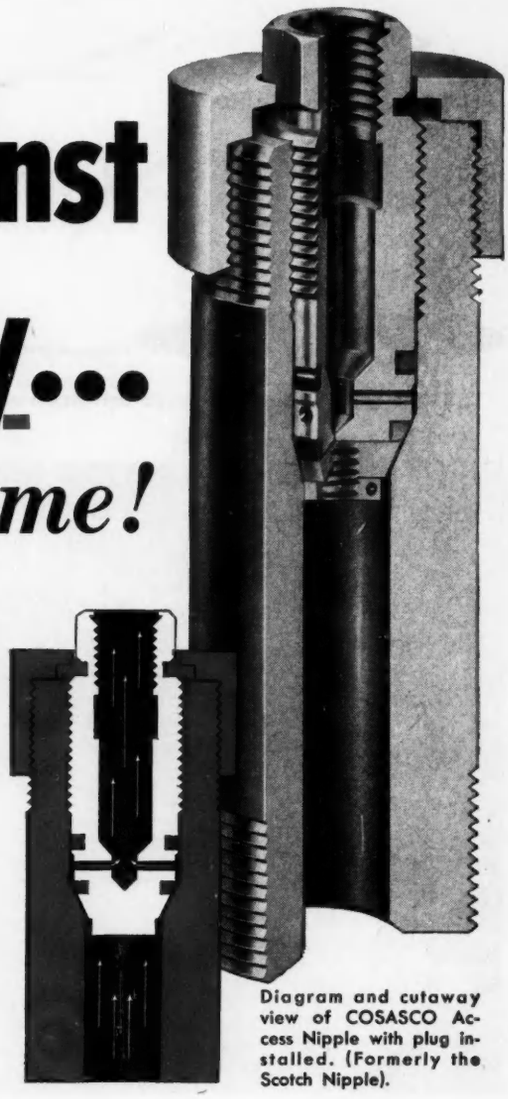


Diagram and cutaway view of COSASCO Access Nipple with plug installed. (Formerly the Scotch Nipple).

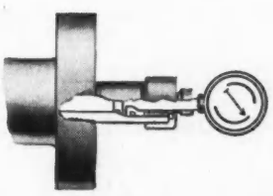
Wherever COSASCO Access Nipples are installed, you can go in against pressure with ease and perfect safety. At well heads, either the production string or annulus can be entered for instrument work. At refineries or along pipe lines, samplers, thermocouples, hydrogen probes, or coupons for corrosion studies can be inserted *without interfering with operations!* And expensive valves or other externals can be replaced or removed at will and without loss of pressure or product.

The COSASCO Access Nipple has a removable low carbon grade 303-304 stainless steel plug which, when turned down on the fine threads in the nipple outlet, effectively seals off the nipple at a tapered seat below. By-pass holes in the plug wall, between primary and secondary seals, provide communication through the plug to the exterior when the plug is backed out against a safety ring run down on the pipe threads on the nipple body.

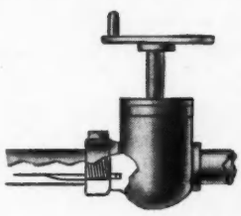
How entry is gained

With the COSASCO Retriever (Lubricator) and a full-opening valve mounted on the Access Nipple, COSASCO plugs, coupon holders or other units for inspection, testing, sampling, can be installed and removed at will regardless of pressure and without equipment shutdown. Details will be supplied promptly, on request.

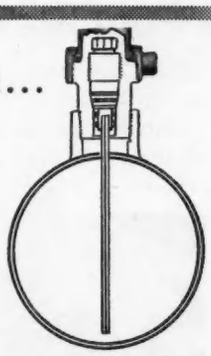
How **COSASCO** *Access* Nipples are used...



As a gauge valve, with plug installed. Gauge screws into end of plug.



As a valve re-installation nipple, with a thread and seat protector replacing the plug.



As a coupon holder for corrosion studies through taps in pipe lines and pressured vessels.

Protect equipment . . . Save product

What's your problem?

If it's an entry-against-pressure problem, COSASCO engineers invite you to submit details. Send blue prints and drawings to depict the problem, and the COSASCO solution will be supplied *without charge.* And you will be under no obligation whatever for this service.

COSASCO Access Nipples are applicable to any pressure or storage system, hydraulic or gaseous.

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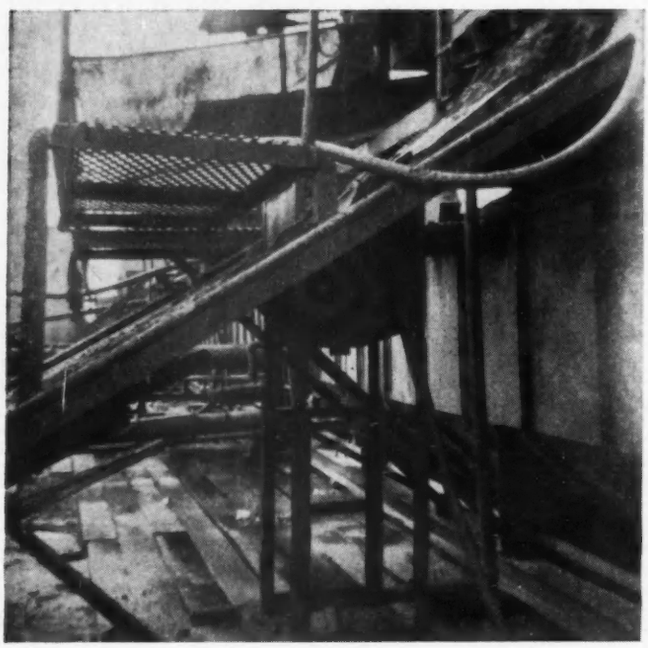
DRILLING HINTS

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Build Cuttings Catcher from Metal Box and Screen Basket

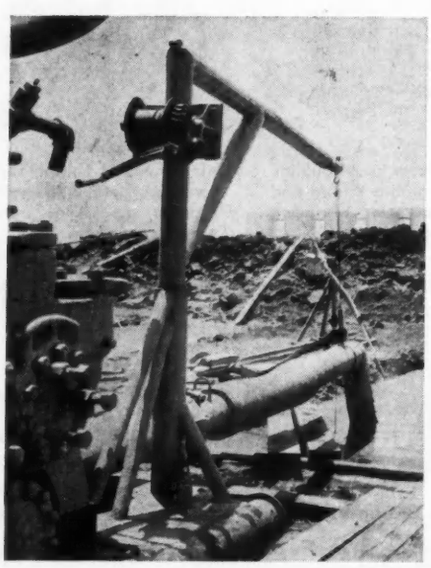
A combination sample catcher and washer can be built easily into the apron attached below the shale shaker. The cuttings catcher consists of square metal box and a pyramid shaped screen basket.

Mount the metal box in the apron as shown. When a sample is desired, insert the screen basket in the metal box. After the sample has been collected, remove the basket and wash it with a good stream of water.

How-To-Do-It Ideas

Earn Money, too!

$10—World Oil editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, World Oil, P. O. Box 2608, Houston 1, Texas.



Braced Upright Lifts Drilling Suction Line

To raise and lower the suction line on a drilling rig, weld a 4-inch upright approximately four feet in length to the end of the pump skid and brace this with joints of 2-inch. A well-braced candilever frame made of 3-inch pipe will fit down inside the 4-inch and is made so that it will swivel inside the 4-inch. Weld a hand-operated winch near the cross piece of the 3-inch pipe. Run a simple arrangement of pulleys at the top of the post and at the end of the candilever, and a small wire line to the neck of the section line. By operating

Seriously this is IT!

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So many improvements have been incorporated in this bit (which was already a proven product)—improvements in construction and engineering, improvements in metallurgy, improvements in tooth design and pattern—that today we firmly believe that any series of tests will prove H. C. Smith 3-Cutter Rock Bits are the best! Men in the field seem to agree... at any rate, so great has been the demand for the new H. C. Smith Bits that our production is now more than ***double our full-capacity output of a year ago.***

The first time you run one of the new H. C. Smith Bits, we believe it will prove to you that

You'll always do better with H. C. Smith Bits!

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Because of these characteristics, Weco Compounds substantially reduce the possibility of downtime resulting from thread failure . . . give drill collar and tool joint threads a longer working life. Get No-Gall or Lo-Tork at your nearest supply store.

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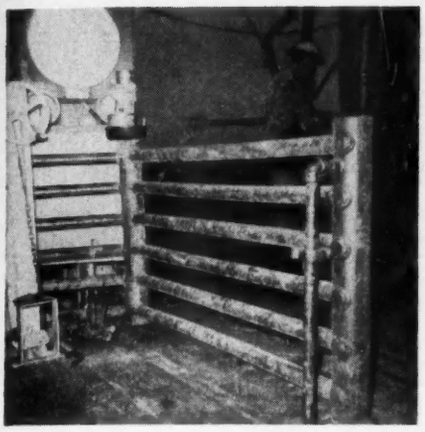
the winch, the suction hose can be raised or lowered and then locked in place.

In transit, the line can be disconnected from the suction hose and the boom swung around and secured in some position across the top of the pump. This places it in a readily available position when moving in on new location.



Use Pipe to Construct Fence Type Steam Heater

Heaters provided to give warmth to the floor crews should be fire proof as well as adequate. Gas fired heaters would certainly be a fire hazard in case a gas pocket was encountered while drilling.

The illustrated steam heater consists of several lengths of pipe welded together to form a fence through which steam can be pumped. The radiated heat provides warmth for the driller as well as crew. A place can also be provided to warm coffee.

Recess Sample Catcher In Shale Shaker Apron

To facilitate the catching of samples in the mud return line, build a sample catcher of small mesh screen and recess it in the apron of the shale

Tips on Mud Valves for Toolpushers . .

Zack Taylor (right) and Toolpusher Jim Wilkson discuss the MUDWONDER on the standpipe of the Falcon-Seaboard Rig No. 9.

Mud Valve Economy, Easy Operation Found In Rockwell-Built MUDWONDER

by Zack Taylor, Division Manager
Falcon-Seaboard Drilling Company, Denver, Colorado

ECONOMY . . . Easy operation . . . Have you searched in vain for mud valves that would give you these benefits? We did until our experience with Rockwell-Built *Mudwonders.* Now, we use them on standpipes, mudlines, mud tanks, blowout preventers, etc. Eight months of testing and using *Mudwonders* proved to us that they are superior to any mud valve we have ever used, regardless of application.

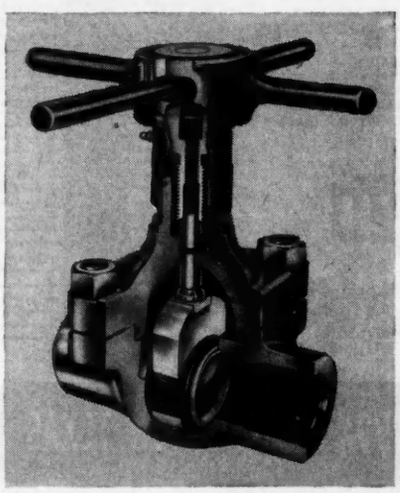
Economy means more to us than just long wearing parts which are inexpensive to replace. It means freedom from downtime and costly maintenance, too. *Mudwonder* valves give us "our type" of economy. We can inspect the inside of a *Mudwonder,* change the seat insert if necessary, and be ready for operation again while the crew makes a connection.

We never need a cheater or hammer on a *Mudwonder* valve. Easy operation is no longer a roughneck's dream. It's real . . . and at extreme differential pressures, too.

We can recommend *Mudwonder* to any toolpusher having mud valve trouble. *Mudwonder* valves are built in 2", 3", and 4" sizes with screwed or flanged ends for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test).

See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana.

MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



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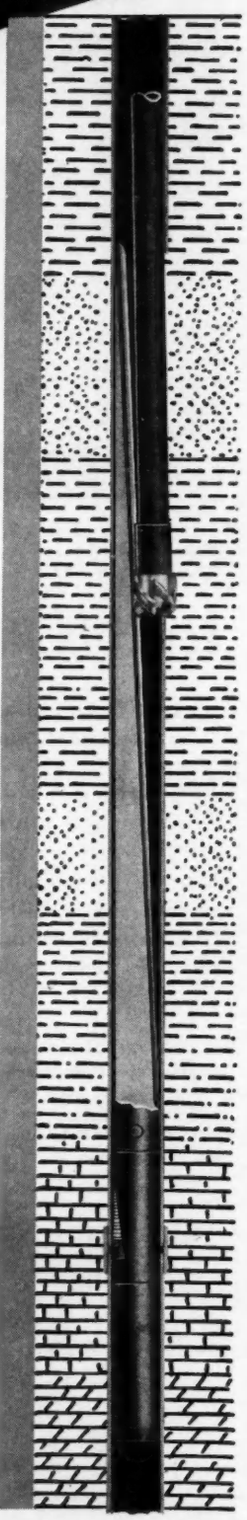
NEW KINZBACH SPEEDMILLS *Slash* DOWN-HOLE CUTTING TIME



UTILIZING TUNGSTEN CARBIDE PARTICLES that continuously renew their cutting edges, new Kinzbach Speedmills offer you faster, surer milling under even rugged down-hole conditions. Because of their extreme hardness, they require fewer replacements . . . fewer round trips.

Kinzbach Speedmills require less torque for cutting . . . eliminate drill pipe wind-up . . . reduce shock on drilling string. They retain their high strength and hardness at elevated temperatures and are unaffected by heat generated by cutting action. Most important, the close control of speed and weight necessary in ordinary subsurface milling operations is not necessary with Kinzbach Speedmills.

For faster cutting . . . surer cutting, be sure your next milling job is done with Kinzbach Speedmills. Types available for every down-hole cutting problem.

Type 154 Speedmill

TYPE 154 SPEEDMILL
This mill is designed for attachment directly to a Kinzbach Type H Whipstock as the first tool in progressive milling operations. After the Whipstock is set, the attachment bolt is sheared and milling operations can begin. The lug on the face of the Whipstock engages the tapered pilot of this mill, forcing it to cut through the pipe wall without thinning the top section of the Whipstock. The Model 154 Speedmill is used to cut the first two and one-half feet of window only.

Type 155 Speedmill

TYPE 155 SPEEDMILL
After the first stage of window cutting is completed, the Kinzbach Model 155 Speedmill is run to complete the window. This tool is designed to utilize cutting force reactions so that maximum length of window may be cut, while side blades are designed to resist reduction in gage diameter during operation.

Type 159 Speedmill

TYPES 156 AND 159 SPEEDMILLS
For general and milling operations. Used to mill up pipe or tools in the well and to shape the ends of obstructing materials for subsequent fishing operation.

Type 156 Speedmill

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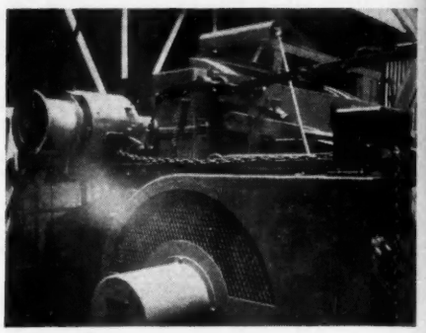
shaker. As cuttings fall from the shaker, they are washed into the sample catcher.

The catcher is simply a rectangular box that fits into the recess in the apron. Lips on the catcher help to hold it in place. For convenience in handling and recovering samples, weld a handle made from a small piece of metal rod to the sides of the container. This forms a bale or handle for the top of the sample catching basket.



Provide Spinning Chain With Labor-saving Guide

Where the spinning chain is hooked to the automatic cathead, a short piece of 3-inch pipe, split down the middle will guide the chain from the cathead to the roller guide and keep the slack from falling down behind the drawworks. This allows more efficient spinning, especially when the initial wrap is taken around the drill pipe to make up a joint.

To make the guide, split the length of pipe down the center line and weld the ends together and spot weld the guide beneath the chain so that it extends from the roller back to a

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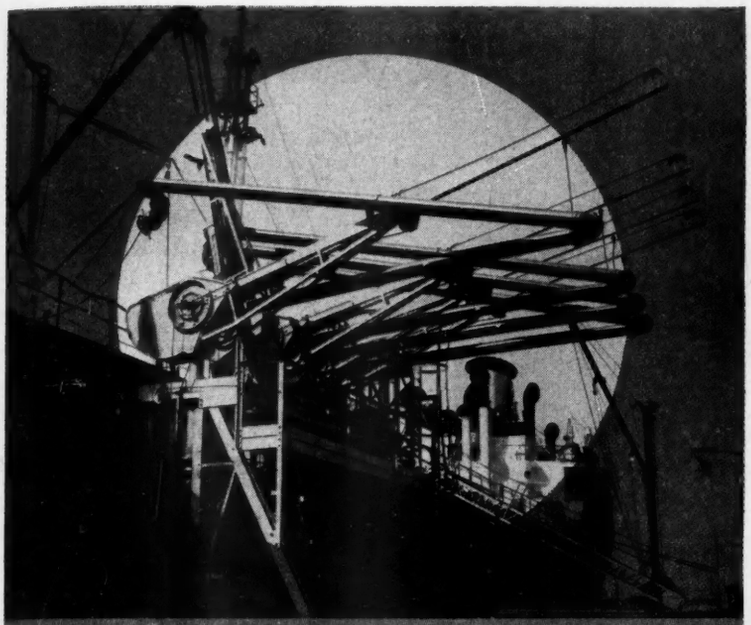
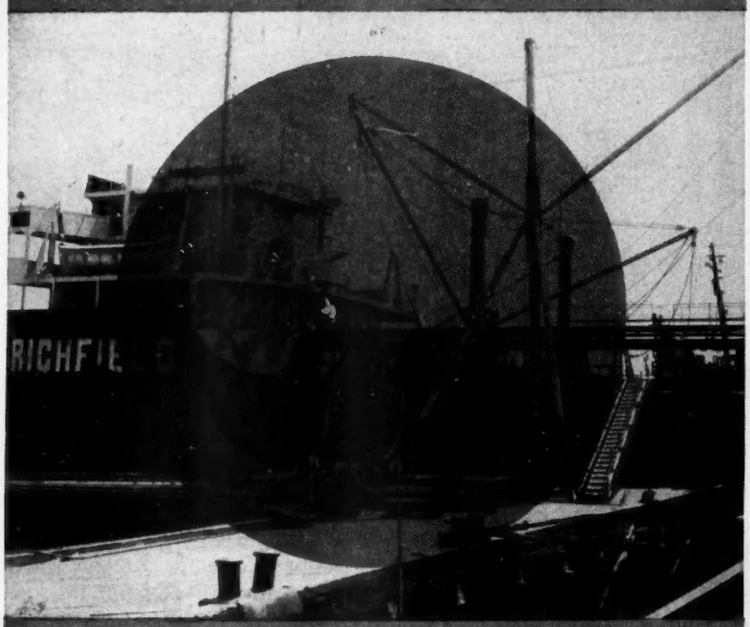


NOW—One man operating simple controls swings Chiksan Loading Arms into hook-up position in one minute. Note spotless condition of the dock.



BEFORE—Unwieldy dock hose was difficult to make up, was hazardous, cluttered the dock and was subject to spillage.

RICHFIELD TERMINAL GOES MODERN WITH CHIKSAN MARINE LOADING ARMS

Safety. Economy. Speed. These three major factors were carefully weighed by Richfield when they evaluated the new Chiksan Marine Loading Arm. On each point the new Loading Arm measured up and more.

Take safety. The majority of marine loading mishaps are back injuries resulting from handling heavy rubber hose. The new hydraulically operated loading arm eliminates this costly hazard. Hose bursts, while less common, are extremely dangerous, terrifically expensive... one burst cleanup could easily cost more than an entire 5-arm unit. The new Chiksan Loading Arm has a burst ratio of 8 to 1 compared with rubber hose 4 to 1 ratio.

From a speed standpoint, it takes 3 men just 7 minutes to make up the Chiksan Loading Arm compared with 7 men taking 24 minutes with rubber hose. Loading operations can be speeded up, materially reducing turnaround time.

And from the all important economy viewpoint, the new Loading Arm means substantial savings in lost man-hours due to injuries, insurance and compensation premiums, and expensive rubber hose replacement costs. Savings that within a decade will actually amount to the purchase price of the Loading Arm.

CONSULT CHIKSAN NOW

If your planning includes a new dock, Chiksan will provide specific detail so that installation requirements can be included in the original plans. If it's an existing dock, Chiksan will tailor loading facilities to meet your requirements.

[redacted]

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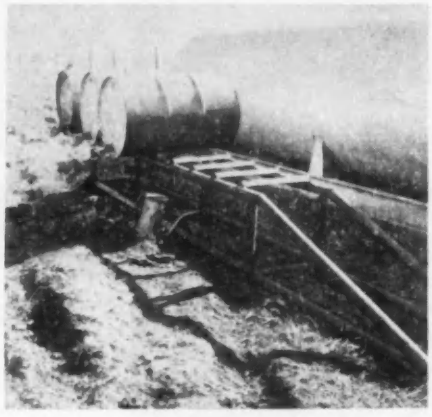
point just beneath the cathead. When slack is formed in the chain, it remains in place and makes it easier to handle on the derrick floor.



Build Lubricant Drum Rack To Ease Handling, Draining

A variety of oils and greases are used for lubricating purposes around a drilling rig. It is necessary that three or four different containers including kerosine and diesel oil be readily available to the crews. To expedite this handling and the emptying of the 55 gallon drums, build a rack of scrap 2-inch pipe and angle line.

As noted in the photograph, make the rack of 2-inch pipe with a platform built at a convenient height for crewmen. To aid in placing the drums on this rack, build an inclined ramp onto one end so that these drums can easily be rolled up and into place.

To hold the drums in position once they are on the platform part of the ramp, cut short pieces of angle line of a sufficient length to match the width of the rack and weld them in place so that they will nest the drums individually. This arrangement provides a good grouping of the oil drums and makes them easy to handle and easy to drain off oil when it is needed around the rig.

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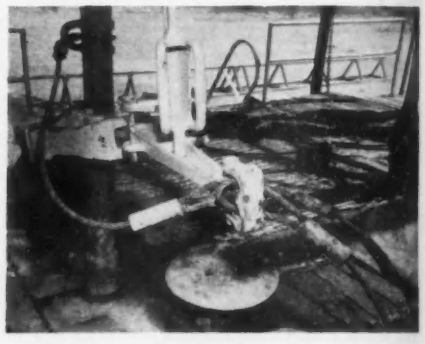


Babbitted Pipe Nipples Protect Against Tongs

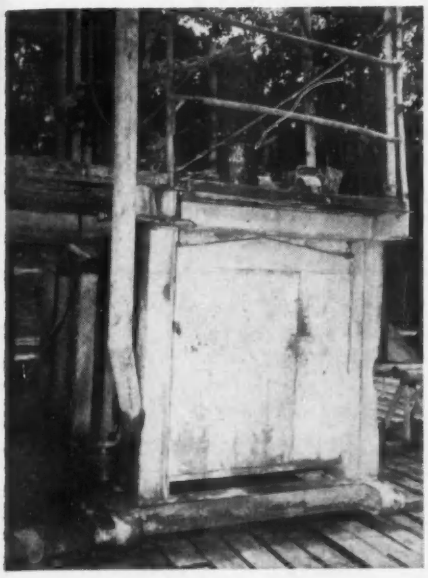
When the wire line clamps hooked onto the sleeve of a roughneck in West Texas, he got the idea that if he used babbitted nipples to fasten the loops on the tong lines the hazard would be eliminated.

The loops are made in the usual manner, but instead of applying the clamps, slip the 1-inch nipples over the ends and plug on the bottom by wrapping with soft rope. After they are filled with babbit and the babbit cooled, use them in the usual manner.

On the other end of the tong lines where they connect to the backup post, use clamps so that the equipment can be easily disassembled.

Space Beneath Rig Floor Provides Movable Doghouse

One drilling contractor noticed that where the rig floor was sectionalized for easy moving that the space beneath the floor would provide space for tools and for the crews to change clothes. All that was neces-



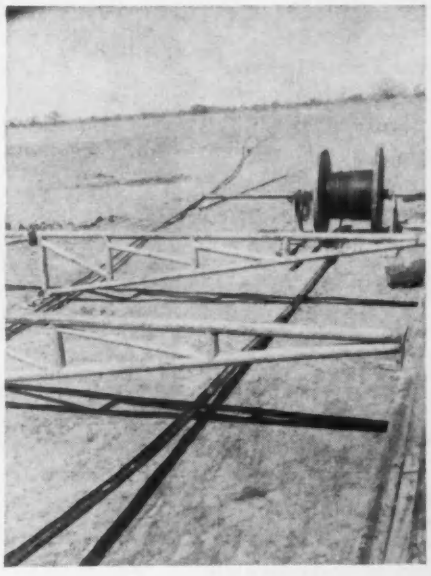
sary was for him to board up the inside of the I-beams which support the rig floor and to put a door on the front and the back.

When it is time to move, all the tools can be thrown into this compartment and locked up. When the rig is spotted on the next location, the tools are removed and the space used for the crews to change and to keep their work clothes.

Tool Bin on Cat Walk End Makes Handling Convenient

One drilling contractor found that the most convenient place to spot the tool bin was at the end of the pipe walk. Here it is out of the way of work around the rig and from mud sprayed from the tool joints, yet is within easy reach of the cat line when a sub or fishing tool was needed.

The bin stands on skids with collapsible legs so that it can be set even with the cat walk. When it is necessary to unload a tool or sub, the cat line is run out, and the tool is easily sucked up onto the rig floor. A post is fixed at the end of the bin for the dead line in laying down drill pipe and this can also be used to swing the tools back into the bin, or the buggy can be used from the catwalk to reload small pieces.



Protect New Drilling Line With Shopmade Trough

Where large spools of drilling line are used for feeding into the derrick as wear progresses, some contractors spot the makeup spool some distance from the rig. In order to prevent wear and abuse to the wire rope, a trough may be made by splitting two joints of 4-inch line pipe. Weld two of the joints together after splitting and lay them with one end on the rig floor and the other down on the ground. Then lay the other double from the lower end of the first out to the spool of wire rope.

This allows the rope to be fed off without any of the cable touching the ground. When it is time to tear down, put the cat line on the side of the spool, and the trough protects the line as it is wound up for transportation to the next location.

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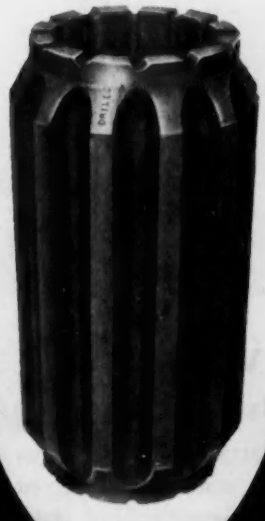

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PRODUCTION HINTS

These How-To-Do-It Ideas Can Save You Money

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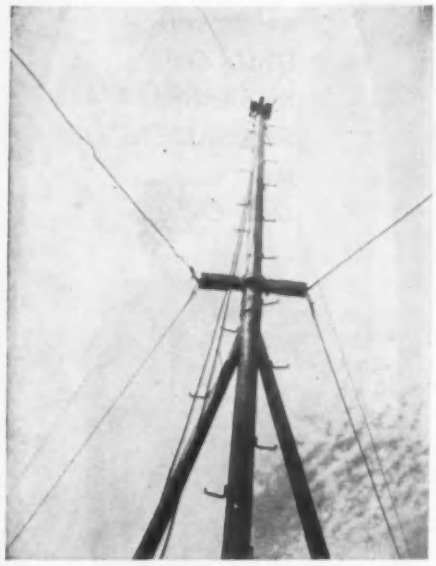


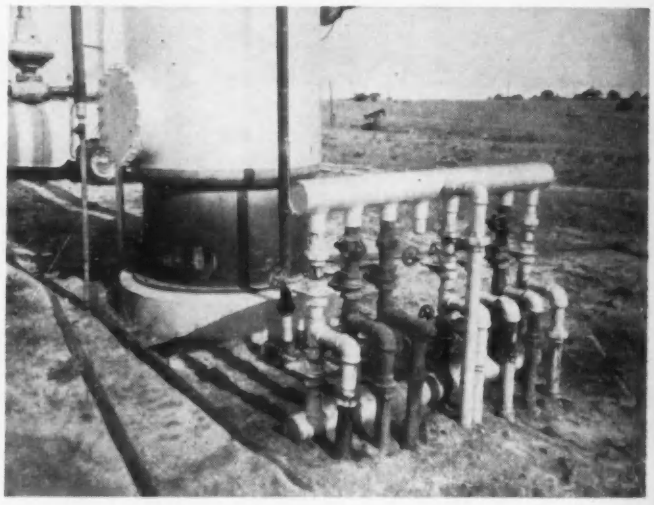
Guy Workover Mast Easily By Using Standard Tubing

To attach additional guy wires to a small workover mast, put a standard tubing or casing clamp on the mast above the side braces and bolt it tight. The two bolts at the ends of the clamp provide a place to which the guy wires may be attached. The method of hook-up is well illustrated by the accompanying photograph.

From this illustration one can see that the guys are kept fairly well away from the ladder on the mast. This allows the rig hands plenty of clearance when climbing up and down the mast.

From a safety point of view it is an excellent installation. Mechanically, too, it looks good. The guys are well separated, the installation can be made while the mast is on the ground and it can be made as a temporary or a permanent installation.

Prefabricated Manifold Speeds Hookup



There are a number of different designs of manifolds in use in the oil field. This one is simple, inexpensive and handy to operate.

To ease the task of directing oil through a separator or a heater treater from several wells as conditions in each well dictate, build and install the illustrated header. It is made of two pieces of 4-inch pipe five feet long or longer depending on the number of wells to be controlled. Drill holes and weld couplings to the sides of the pipe. Connect these to the unions, tees and gate valves, as shown, required for the operation. Also install connections in each header for the outlet lines. In this case the upper line goes to the treater, the lower to the separator.

The location of the valves makes it an easy matter for the pumper to determine quickly the course of flow for the fluid from each well.

How-To-Do-It Ideas Earn Money, too!

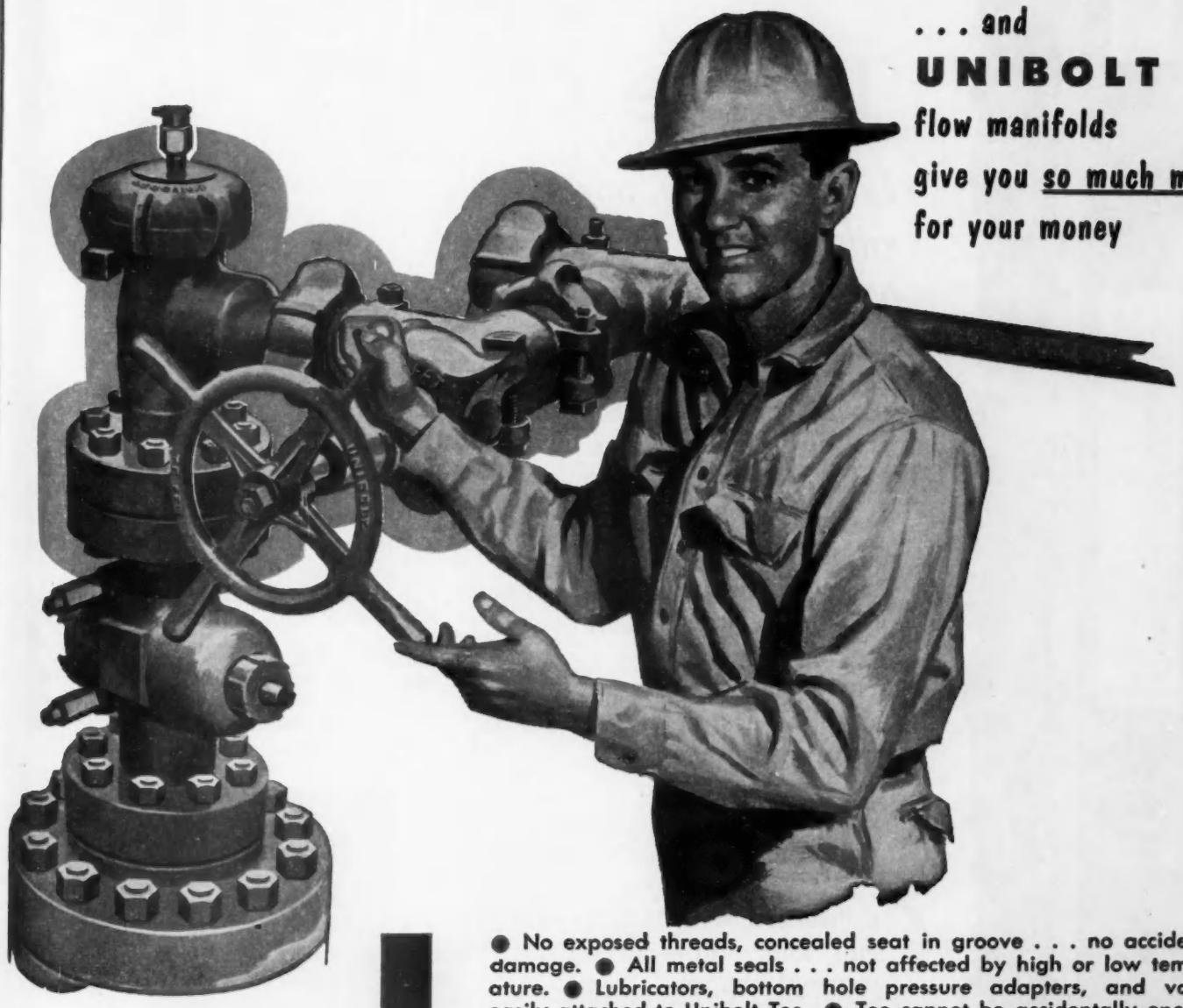
$10—World Oil editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, World Oil, P. O. Box 2608, Houston 1, Texas.

Lightweight Pump Guard Is Easy to Disassemble

Too often it's a major project to disassemble the guard around a pumping unit when access to the well is required. This light weight guard eliminates that problem and still provides adequate protection.

To duplicate this railing, weld ½-inch of ¾-inch rod in the pattern illustrated to fit your well and pumping unit. Set short lengths of 1-inch pipe, at least a foot long, in the ground at intervals that will accomodate the guard legs. Weld a small metal disc to each leg about a foot from the end, as shown in the circle

It costs so little more to "go first class"



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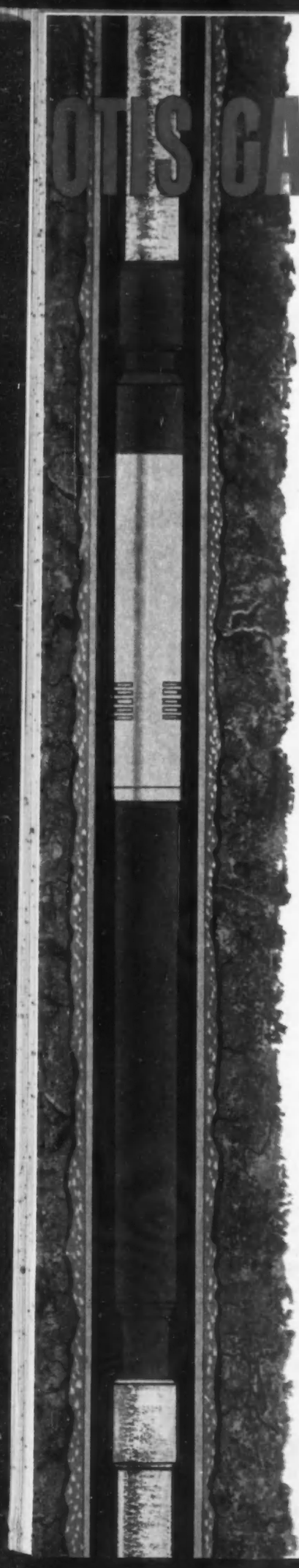
10000 lbs. w.p.

and in "SA" stainless steel for corrosive conditions.

● No exposed threads, concealed seat in groove . . . no accidental damage. ● All metal seals . . . not affected by high or low temperature. ● Lubricators, bottom hole pressure adapters, and valves easily attached to Unibolt Tee. ● Tee cannot be accidentally opened. ● Unibolt stronger than tubing threads . . . ideal for working trees with welded lift nipple. Tubing threads in Tee if desired. ● Wing Valve requires no grease to effect seal. ● Variable opening speeds up initial clean-up or running initial flow tests . . . saves rig time. ● Unrestricted 1" opening in Wing Valve will pass 10,000 bbls. fluid per day with 100 lbs. pressure drop. ● Valve stem packing needs no tightening . . . stem turns freely under high pressures. ● Threads on stem not exposed to internal or external damage . . . full 2½" pilot for true stem alignment and rigidity. ● Stem seat sealed by power threads and metal gasket assures alignment. ● Nitride hardened stem and stem seat . . . resists corrosion. ● Choice of hard chrome plated or "SA" stainless stems and seats. ● Positive Choke Body takes regular or "X" Beans . . . all beans flow-rated. ● Shaped entrance on beans prevents paraffin clogging. ● Positive Choke Body may be replaced with inexpensive tee and cage nipple, or can be converted to Adjustable Wing Valve by substituting two parts. ● Streamlined flow . . . no obstructions . . . no turbulence.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS



OTIS GAS LIFT VALVE

Type C

Largest flow ports . . . smallest O. D. of any available valve

So different from conventional valves we believe it has advanced gas lift technology by ten years.

- Valves can be used for either continuous or intermittent flow
- No metal moving parts — the simplest design of any gas lift valve on the market
- Operated with casing pressure—independent of tubing pressure
- Concentric with tubing—easy to run and pull — no offsets, no unusual shapes
- Available in a wide range of sizes and bore diameters — from ¾" x 1¾" to 2½" x 4"

Your nearest Otis office will be glad to give you additional information and illustrated literature. There is no obligation of course.

PRESSURE CONTROL OTIS SERVICE — EQUIPMENT

OTIS PRESSURE CONTROL, INC.

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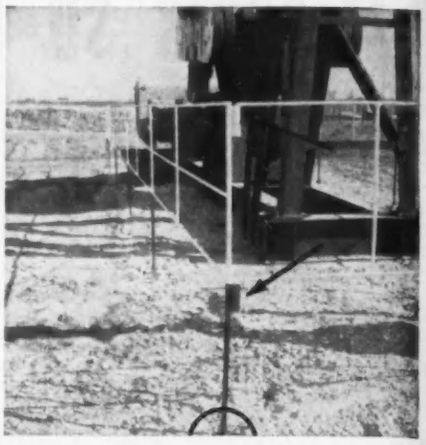
Branches Throughout the Oil Country

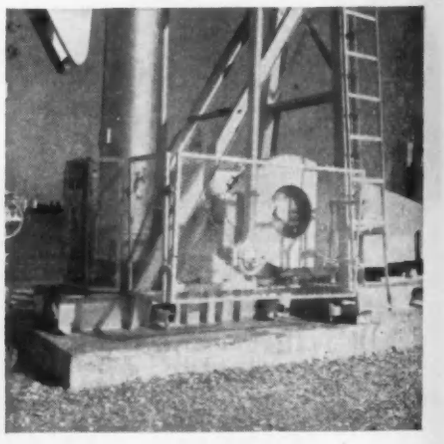
PRODUCTION HINTS . . .



on the photograph, which will rest on the top of the pipe. By adjusting the height of the pipes you can level the guard rail. The discs also act as covers for the pipes in the ground eliminating dirt or debris which might cause the legs to stick.

A simple attachment device makes each end of the guard rail separately removable. This is pointed out by the arrows on the photograph.

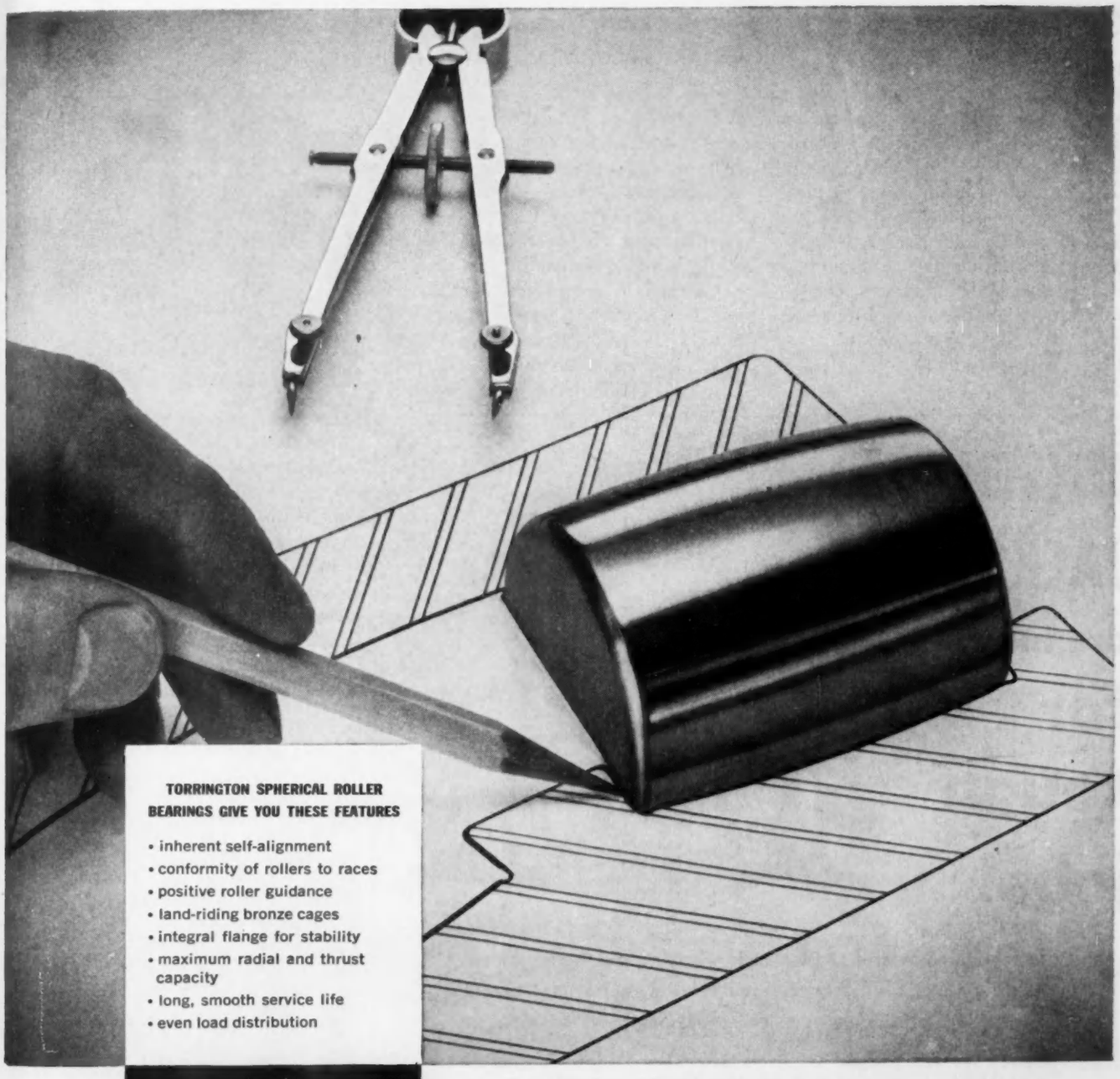
Weld short pieces of pipe to the legs at each end, as shown. Put a right angle bend in the ends of the horizontal members of the rail, and the device is complete. It makes a neat appearance and is easy for one man to handle.



Sturdy Screen Encloses Air-Balanced Pump

This air balanced pump is enclosed by an excellent guard screen. It is a sturdy, well designed assembly that allows quick access to the enclosed equipment. Each section is either individually removable or capable of swinging open like a gate to permit entrance.

Make the frame of 1½ x 1½-inch angle iron. Cut the expanded metal



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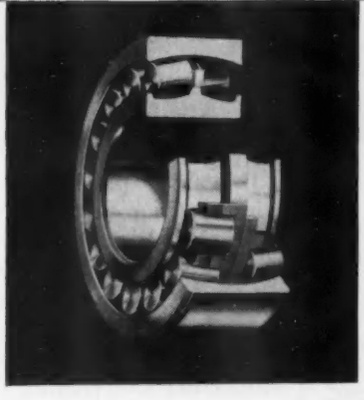
- conformity of rollers to races
- positive roller guidance
- land-riding bronze cages
- integral flange for stability
- maximum radial and thrust capacity
- long, smooth service life
- even load distribution



Mated perfectly ~ for life!

Make a point to notice the roller end and center guide flange in a Torrington Spherical Roller Bearing. The perfect mating there means a smoother, longer bearing life.

Roller end and flange surfaces alike are ground to a common spherical radius centered on the common vertex of bearing axis and roller axis. Under all load conditions, the rollers bear lightly but constantly against this flange. This guides the roller positively with minimum friction and prevents skewing. Stress concentrations leading to early failure are avoided, so the bearing will serve you many good turns longer.

This is the kind of feature Torrington builds into its bearings out of its experience with all major types serving in all kinds of equipment. Care for such details is matched only by our care in mating the *right* bearing to the *right* job. In this, your Torrington representative is an expert: call on him when you need help. *The Torrington Company*, South Bend 21, Ind.—Torrington, Conn.

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District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

to fit the frame and weld it in place. Weld simple dove-tail type hinges to each section of frame with removable bolts as pivots. Bolt the angles at the front and rear of the frame, which lie across the I beam skids, in place.

This arrangement allows the frame in front of the air cylinder to be unbolted and removed. The sections on either side may be swung out of the way on the hinges when it is necessary. This is a neat appearing and effective guard for pumping equipment.

Cradle Fuel Tank Drum On Skid-Mounted Pump Unit

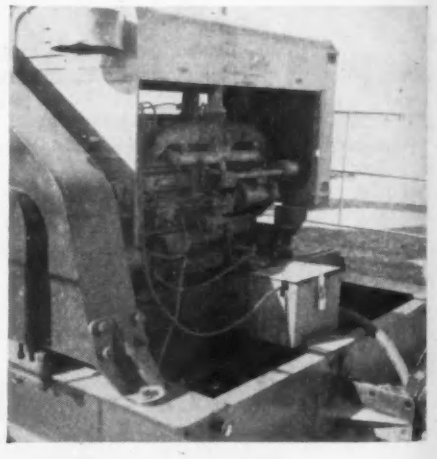
This 50-gallon drum is used as a fuel tank for the gas engine on a skid-mounted pumping unit. The method of positioning the drum is very simple. It consists merely of a cradle made of two sheets of ¼-inch steel welded to pieces of 1½-inch angle iron supported by the skid.

Cutting an arc in the steel sheets equal in diameter to the barrel diameter allows the barrel to fit snugly in place. Be sure to cover a sufficient amount of the barrel circumference

to prevent it from rolling too easily out of the cradle.

Another consideration is the height of the barrel. If you are going to depend on a gravity flow to supply the engine with fuel, the barrel outlet should be slightly above the engine intake point. This can be regulated either by the sheet steel plates or the frame supports, as you desire.

The result is a simple, good-looking workable method of spotting a fuel barrel.



Provide Storage Battery With Protective Container

Provide a protective container of some sort for the storage battery on an engine driven pumping unit. The sheet steel box illustrated can solve the problem.

Make the box 3/16-inch steel plate and weld it to part of the frame supporting the engine. Cut a notch in the side to admit the electric cable. To make the unit complete, weld two hinges to the back edge of the lid and a hasp to the front.

The storage battery is in a handy position, is protected from the customary damage of oil field activity and is under lock and key.

JENSEN JACKS are made for tough jobs!

In remote corners of the oil world where production problems are the worst, and service is miles away, sometimes across the world, that's when you need a JENSEN.

A JENSEN is rugged and dependable . . . seldom needs service. If parts are ever needed, you can get them quickly. JENSENS keep costs down and profits up . . . 37 years of experience proves it!

When you get a tough pumping job—get a JENSEN. See your nearest JENSEN Dealer or write us.

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JENSEN BROS. MFG. CO., INC.
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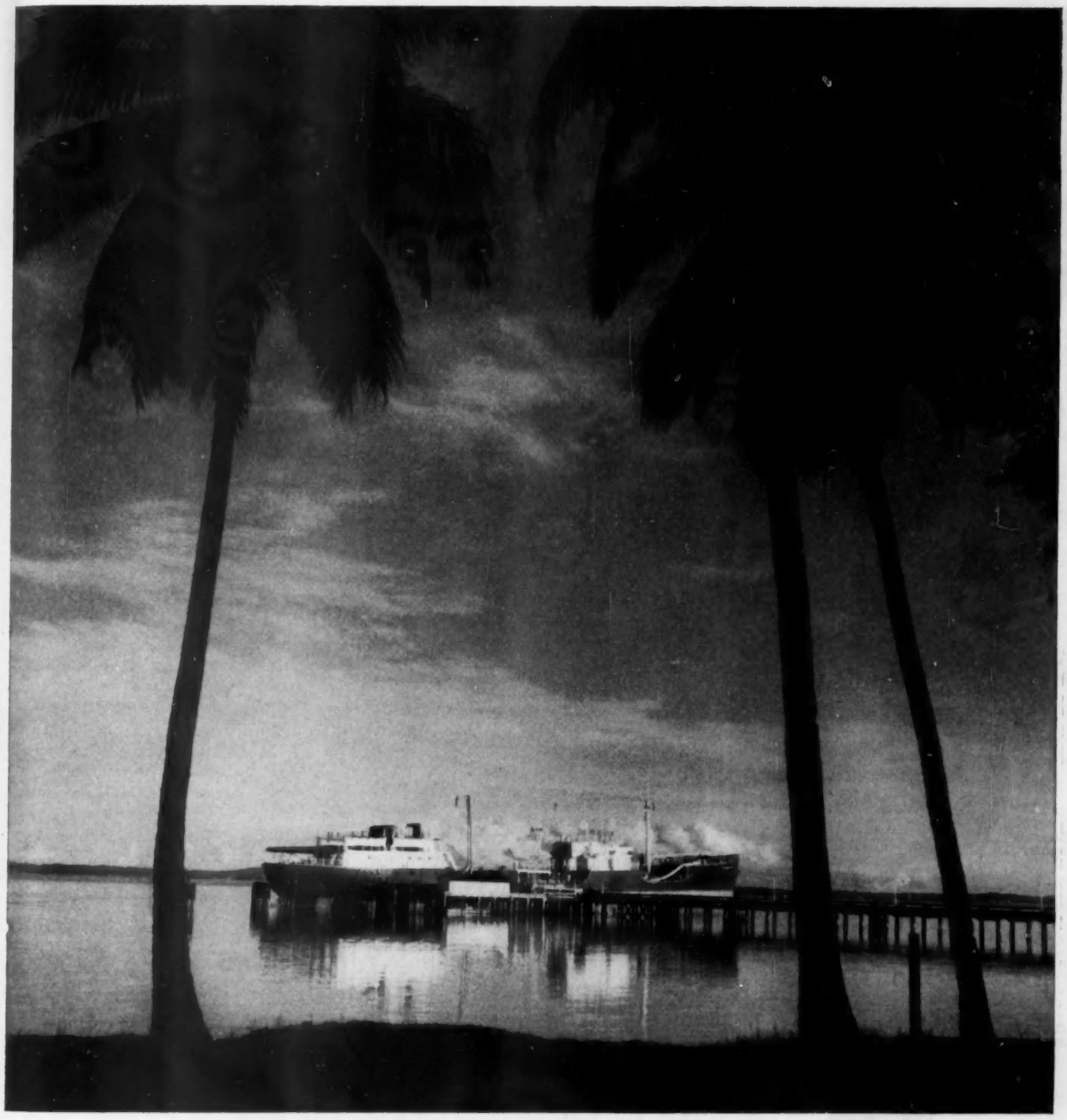

"Change is a law of life. But what is disturbing is evidence now and then of a drift backward to the old notion that agreements are merely scraps of paper. The world cannot be organized for its own good on any such foundation of irresponsibility. We must be able to rely upon each other's word. There is no other principle on which people and nations can work together for progress and their mutual benefits."

— Eugene Holman, Chairman of the Board, Standard Oil Company (New Jersey)

ESSO 75 YEARS

producing energy for an abundant life

STANDARD OIL COMPANY (NEW JERSEY)
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DARCOVA
now offers...
• MORE STRENGTH
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with 100% NYLON COMPOSITION!

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and *only* in DARCOVA can you get this time-saving, money-saving advantage! Available in the full range of sizes and Darcova textures for varying well conditions.

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There is no substitute!

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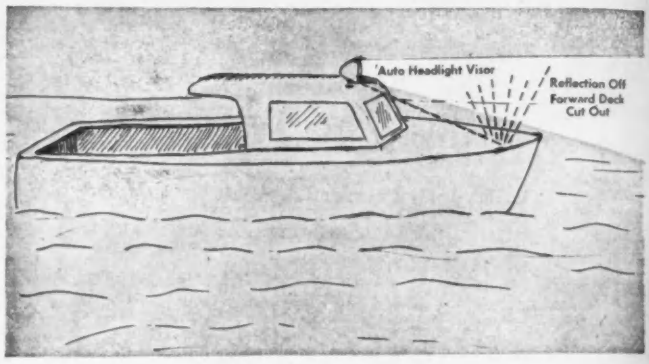
THE ORIGINAL COMPOSITION CUP

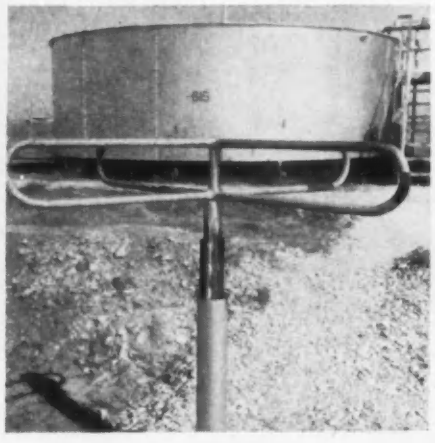
Spotlight Visor Aids Night Vision on Boats

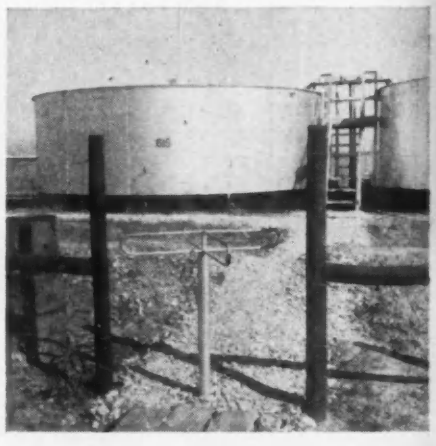


Boat crews along the Louisiana coast have found that the new high intensity spotlights recently installed were often doing more harm than good. Much of the light was being reflected off the forward top deck, blinding the driver.

To correct this some of the crews installed automobile headlight visors on the bottom of the spotlight. This blanked out that part of the beam that was hitting the deck. The results achieved more than compensated for the 20 cents per visor cost. Night vision improved and the operating efficiency of the boat driver was greatly increased.

To reduce the effect of corrosion on both the light and the visor a high quality rust proof finish was applied.





Replace Gate With Turnstile of Pipe

Here is a simple turnstile that can be made quickly and inexpensively from used pipe and reinforcing rod.

The four, ¾-inch, reinforcing rod, arms are formed and welded to an 18-inch length of 1-inch rod as illustrated. The 1-inch rod is then inserted through a piece of 1½-inch pipe and tack welded to it at the bottom.

To provide stability for the turnstile, use a length of 2-inch pipe as a post in which to place the rotating part of the unit. To fill the gap between the OD of the small pipe and the ID of the 2-inch pipe weld pieces of small diameter rod. These rods act as a bearing surface and eliminate excess horizontal play in the arms.

The close-up provides a detailed view of the assembly of the unit, while the other photo illustrates its neat appearance.

Load Heavy Equipment On Car Trailer With Winch

The business of transporting tools and equipment to the field has resulted in a variety of trailer designs. Here is a model for carrying heavy fishing tools that may find a number of applications.

One of its novel features is the hand

more power to you

for more oil field jobs

All through the oil fields, you'll find abundant proof of the stamina that has made Continentals first choice for so many tough jobs. This Red Seal Model F-162 closed power unit, driving 4 x 6 Dean pump, furnishing water for a 6,500-foot drilling rig in Stonewall County, Texas, replaced another Red Seal which had been in service continuously for eight years. There are Red Seals engineered for every oil field application, at closely-spaced power levels, and available for use on all standard fuels. Ask your oil field supply store or get in touch with the nearest Continental Office.

• • •

GASOLINE AND LPG ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N56	4	2¼	3½	56	14.4 @ 2200 RPM
N62	4	2⅜	3½	62	15.3 @ 2200 RPM
Y69	4	2½	3½	69	21.4 @ 2400 RPM
Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3 3/16	3½	112	32.0 @ 2400 RPM
F124	4	3	4⅜	124	36.5 @ 2400 RPM
F140	4	3 3/16	4⅜	140	42.0 @ 2400 RPM
F162	4	3 7/16	4⅜	162	49.0 @ 2400 RPM
F186	6	3	4⅜	186	60.5 @ 2400 RPM
F209	6	3 3/16	4⅜	209	68.0 @ 2400 RPM
F226	6	3 5/16	4⅜	226	73.0 @ 2400 RPM
F244	6	3 7/16	4⅜	244	79.0 @ 2400 RPM
M271	6	3⅝	4⅜	271	86.2 @ 2400 RPM
M290	6	3¾	4⅜	290	92.2 @ 2400 RPM
M330	6	4	4⅜	330	104.4 @ 2400 RPM
M363	6	4	4 13/16	363	128.9 @ 2800 RPM
B371	6	4⅛	4⅝	371	110.0 @ 2400 RPM
B427	6	4 5/16	4⅞	427	127.0 @ 2400 RPM
G134	4	3⅛	4⅜	134	34.2 @ 2000 RPM
G157	4	3⅜	4⅜	157	40.0 @ 2000 RPM
E201	4	3⅝	4⅞	201	65.4 @ 2400 RPM
H227	4	3⅝	5½	227	54.0 @ 1800 RPM
H243	4	3¾	5½	243	57.9 @ 1800 RPM
H260	4	3⅞	5½	260	62.0 @ 1800 RPM
H277	4	4	5½	277	66.4 @ 1800 RPM
K363	6	4	4 13/16	363	123.0 @ 2400 RPM
J382	4	4½	6	382	74.0 @ 1400 RPM
T371	6	4⅛	4⅝	371	119.0 @ 2400 RPM
T427	6	4 5/16	4⅞	427	140.0 @ 2400 RPM
U501	6	4½	5¼	501	159.0 @ 2400 RPM
R513	6	4½	5⅜	513	164.3 @ 2400 RPM
R572	6	4¾	5⅜	572	182.4 @ 2400 RPM
R602	6	4⅞	5⅜	602	191.7 @ 2400 RPM
V603	8	4¼	4¼	603	220.0 @ 2800 RPM
S749	6	5⅛	5½	749	217.0 @ 2200 RPM
S820	6	5⅛	5½	820	237.0 @ 2200 RPM

CUSHIONED POWER DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
ZD129	4	3¼	3⅞	129	34.0 @ 2000 RPM
GD157	4	3⅜	4⅛	157	39.0 @ 2000 RPM
*ED201	4	3⅝	4⅞	201	45.8 @ 2000 RPM
HD243	4	3¾	5½	243	55.0 @ 2000 RPM
*HD260	4	3⅞	5½	260	59.0 @ 2000 RPM
*HD277	4	4	5½	277	63.2 @ 2200 RPM
*JD382	4	4½	6	382	72.5 @ 1600 RPM
TD427	6	4 5/16	4⅛	427	106.0 @ 2000 RPM
RD572	6	4¾	5⅜	572	154.0 @ 2000 RPM
VD603	8	4¼	4¼	603	175.0 @ 2600 RPM
SD802	6	5 5/16	5½	802	202.0 @ 1800 RPM

*Available for industrial applications only.

SERVICE FACILITIES AND GENUINE RED SEAL PARTS AVAILABLE EVERYWHERE

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Continental Motors Corporation

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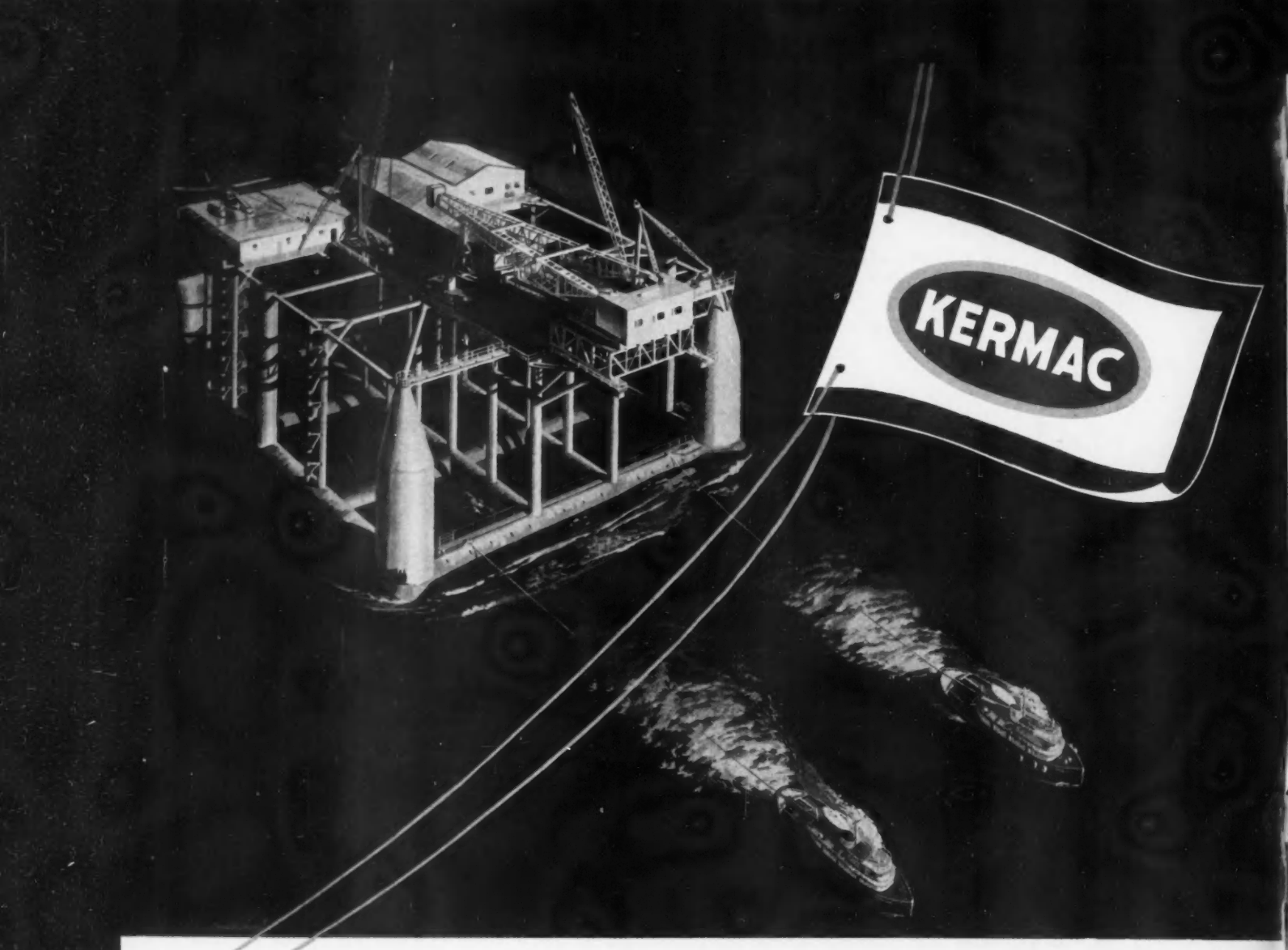
GOOD EQUIPMENT IS BETTER WITH CONTINENTAL RED SEAL POWER



KERMAC RIG 46

heads for open water...

Rig 46, in tow to its first location by powerful G & H 1700-horsepower tugs GRAMPUS and PIKE, measures 242 feet in length, 202 feet in width and is designed to operate in water depths to 70 feet. With a weight on bottom of 5000 tons, it is another new giant for the offshore oil fields.

Kermac Rig 46, newest addition to the growing fleet of offshore drilling equipment owned and operated by Kerr-McGee Oil Industries, Inc., represents a new principle in drilling barge design. Free of moving parts—no pontoons and no deck elevation equipment—this self-contained unit is the world's largest ocean-going drilling barge—tallest floating structure—and largest submarine now in operation. With a working area 100 feet above the base line, nearly as large as a city block, Rig 46 is a massive structure to move from place to place.

With more than 35 years diversified marine experience to guide them, G & H Towing Company has pioneered in offshore towing of mobile drilling platforms . . . providing dependable towing teamwork for the oil industry offshore. Equipped with one of the most modern, thoroughly inspected diesel tug boat fleets afloat, operated by fully licensed crews who know and respect the sea, G & H can dependably and economically tow anything that floats . . . anytime, anywhere.

Call the G & H office nearest you today and let us help you solve your offshore towing problems. No obligation, of course.

G and H

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G and H TOWING COMPANY INC.

FLEET OF MODERN 700 TO 1700 HP TUGBOATS FOR EVERY TOWING REQUIREMENT

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GALVESTON
802 U. S. National Bank Building
CORPUS CHRISTI

winch mounted on a bracket at the front of the trailer. It is set high enough to allow the cable to pass easily over the rear of the trailer and will have a tendency to lift the tools in the troughs.

An ordinary automobile axle is used for the trailer with 10-inch pipe cut longitudinally to form the troughs. Two-inch angle iron is used to mount the winch and a thin gage sheet steel is used on the remainder of the unit.

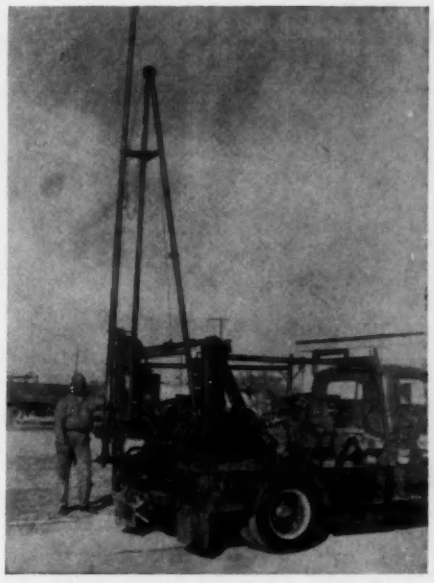
Build Inexpensive Shack From Corrugated Iron

If a small, inexpensive pumper's shack is what you need, this suggestion may be of value. Make this corrugated iron unit of 2 x 4 and 1 x 6 inch lumber with a cheap, standard door for an entrance. Because of its simple design, this unit can be made at the shop and transported to the location at which it is needed. When the circumstances are changed, it can be moved easily to another location and set up on blocks as illustrated.

As a temporary unit it is hard to beat for cost, simplicity and results. It is small enough to be easily handled and large enough to be useful.

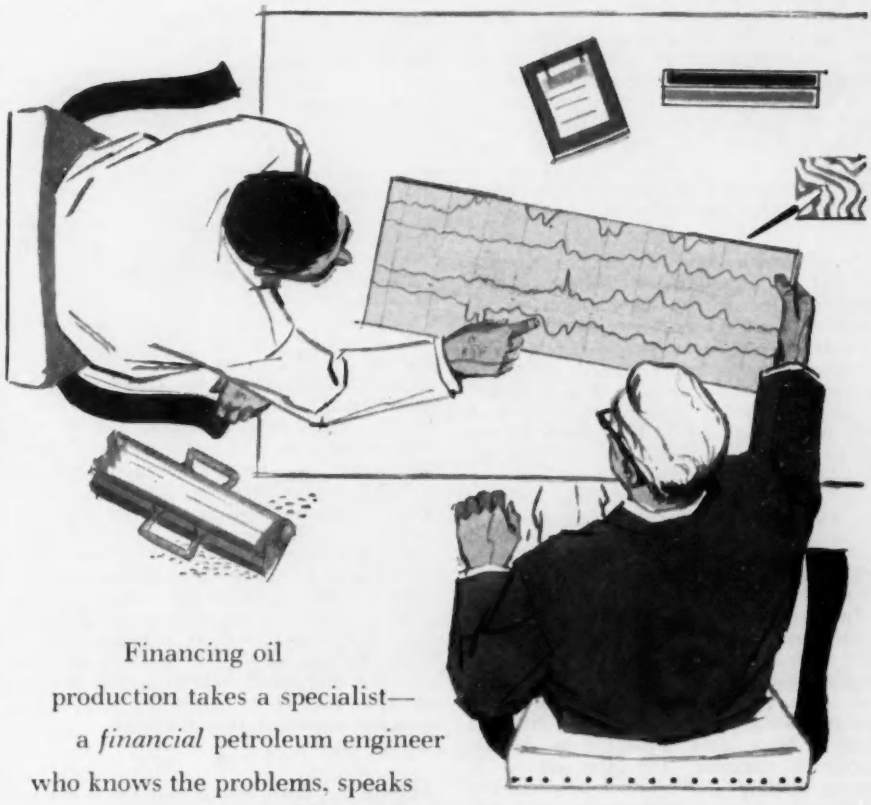
Handy A-Frame Helps Maintenance Safety

Install this counter-balanced A-frame, which can be raised and lowered with a hand winch, in the rear of a paraffin scraping unit. It reduces the time required to set up the lubricator and blow-out preventer assembly so that paraffin scraping operations can be performed. In addition, safety is enhanced by the elimination of manual lifting of the blow-out preventer and by providing a better means of lifting the lubricator into position.



Let's talk over your

PRODUCTION FINANCING



Financing oil production takes a specialist— a *financial* petroleum engineer who knows the problems, speaks the language of the producer.

Texas National's financial engineers have many years of experience in financing oil production which can be put to work for you. Come in and let's talk it over.

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

TEXAS National BANK OF HOUSTON

What's Happening

AMONG MEN IN THE INDUSTRY

William B. Moses, Jr.

Dwight L. Simmons

Seaboard Oil Company has approved the election to the board of **William B. Moses, Jr.**, and **Dwight L. Simmons.** Simmons has represented Seaboard in Dallas since prior to 1934. He is a managing partner, law firm Thompson, Knight, Wright & Simmons, with whom he has been associated since 1926 and of which he has been a partner since 1934. He is engaged in the general practice of law, having specialized in oil and gas practice for 25 years, both in litigation and office practice. Moses, a trustee of Massachusetts Investors Trust of Boston, has specialized for many years in the analysis of oil and natural gas investments and has been associated with Massachusetts Investors since 1941. He has been a trustee since 1953 and was made a director of the Massachusetts Investors Growth Stock Fund that same year.

•

R. S. Tremaine has been named district geologist in **Stanolind Oil and Gas Company's** Casper district Exploration office, replacing **Ian Macartney** who has been transferred to the company's Foreign Exploration department. Tremaine moves to Casper from San Antonio, Texas, where he has been district geologist for Stanolind since November, 1955. He joined Stanolind as a junior geologist in 1948, in the Houston district Exploration office, and served as area geologist in New Orleans from 1953 until he moved to San Antonio.

•

Murray B. Quigles, Jr., district petroleum engineer for **Union Producing Company** at Jackson, Miss., has been transferred to Houston and promoted to assistant drilling and production superintendent. Quigles went to work for the company in Shreveport as a production engineer in 1946. The following year he was transferred to Tinsley, Miss., and promoted to district petroleum engineer. He later served in various drilling and production capacities at Shreveport and Houma, La. In 1955 he was advanced to district petroleum engineer at Jackson.

•

Phillips Petroleum Company's division and district production offices made several changes. The Philtex division office, located at Ponca City, Okla., was closed, and **M. L. Atkinson**, formerly its superintendent, became superintendent of the Central division, headquartered at Oklahoma City, Okla., succeeding **George J. Turner**, who retired. The North Burbank and South Burbank district offices, which previously comprised the Philtex division, became a part of the Central division. The North Central Texas district, headquartered at Wichita Falls, Texas, and previously at part of the Central division, was added to the Plains division, which is headquartered at Amarillo, Texas. Atkinson joined Phillips in 1925 and was superintendent of the Philtex division for 11 years prior to assuming his new duties. Turner, who started with Phillips in 1929, was superintendent of the Central division for 11 years before his retirement.

•

L. H. Betow has been promoted to the newly created position of assistant to **Harold G. Osborn**, senior vice president of **Continental Oil Company.** Formerly resident chemist at Conoco's Lake Charles refinery, he will make his new headquarters in Houston. Betow joined Conoco in 1944 as an analytical chemist at Ponca City, Okla. He was resident chemist at the company's Artesia, N. M., refinery before transferring to Lake Charles in 1949.

•

John T. Cooke, manager of economic research for **Sohio Petroleum Company** in Oklahoma City, has been appointed to the newly created position of manager of foreign operations. In this new position, Cooke will be responsible for the conduct of the foreign operations for the Production department of Sohio, excluding Canada. Canadian operations will continue to be a part of the Northwest division headquartered in Billings, Mont. As foreign operations manager, Cooke will direct studies involving foreign areas where Sohio may in the near future desire to establish or enlarge its activities. Cooke joined Sohio in 1947 as reservoir engineer in the West Edmond field following three years in a member firm of the New York stock exchange and eight years with another major oil company. Cooke became staff assistant to the manager of production operations in 1950, and three years later, he moved to the position of manager of industrial relations. In August, 1955, he became manager of Sohio's headquarters economic research staff.

John T. Cooke

•

Marvin L. Ratts has joined the technical staff of **Shields Oil Producers** and will specialize in well completions and production. He previously was employed by Dowell, Inc., in Hugoton and Great Bend.

•

Joseph H. Moran has been named to a newly created post, that of director of trade relations for **The Texas Company.** Moran will coordinate liaison in New York between the company and its customers in the interest of trade relations. **Durrett Hendrix** has been named Moran's successor as manager of Texaco's Marine Sales division.

Hugh W. Curfman recently joined **Christie, Mitchell and Mitchell Co.** as district manager in Lafayette, La. His work there includes buying leases, doing exploration work which includes geological evaluation and seismic evaluation and drilling in southwest Louisiana. Previously, he had been with Sun Oil Company for seven years where he held the position of assistant district geologist. Then, for a year and one half, he was with Southern Production Company as district geologist for southwest Louisiana. When Southern Production was purchased by Sinclair Oil Corporation, Curfman joined Christie, Mitchell and Mitchell.

Hugh W. Curfman

•

Stanolind Oil and Gas Company's Exploration department has promoted **D. E. Powley** to division geologist replacing **R. O. Mitchell**, who has moved to the company's general office in Tulsa. **M. R. Waller** becomes district geologist in the Calgary district office, succeeding Powley. Powley joined Stanolind in 1951. He has held various geological assignments in Regina and Calgary, and was made Calgary district geologist in 1955. Waller has been area geologist in Stanolind's North Canadian district office. He joined Stanolind in 1952 as a junior geologist.

•

The University of Oklahoma School of Geology is preparing a new directory of its former major students and graduates. It is attempting to compile a reasonably up-to-date mailing list for a proposed semi-annual newsletter. All men and women who received part of their academic training in geology at the University of Oklahoma are urged to send the department or **Dr. V. E. Monnett**, their present address and such information as would be of interest to others who were once enrolled at the University.

•

James D. Stahl, Houston district petroleum engineer for **Union Producing Company** for the past two years, has been appointed field drilling and production superintendent. **Ervin O. Veselka**, the company's field drilling and production superintendant at Houma, La., will succeed Stahl as district petroleum engineer. Stahl went to work for Union at Shreveport in 1941. He was transferred to the Houston district in 1951 and promoted to assistant petroleum engineer. In 1954 he was advanced

James D. Stahl

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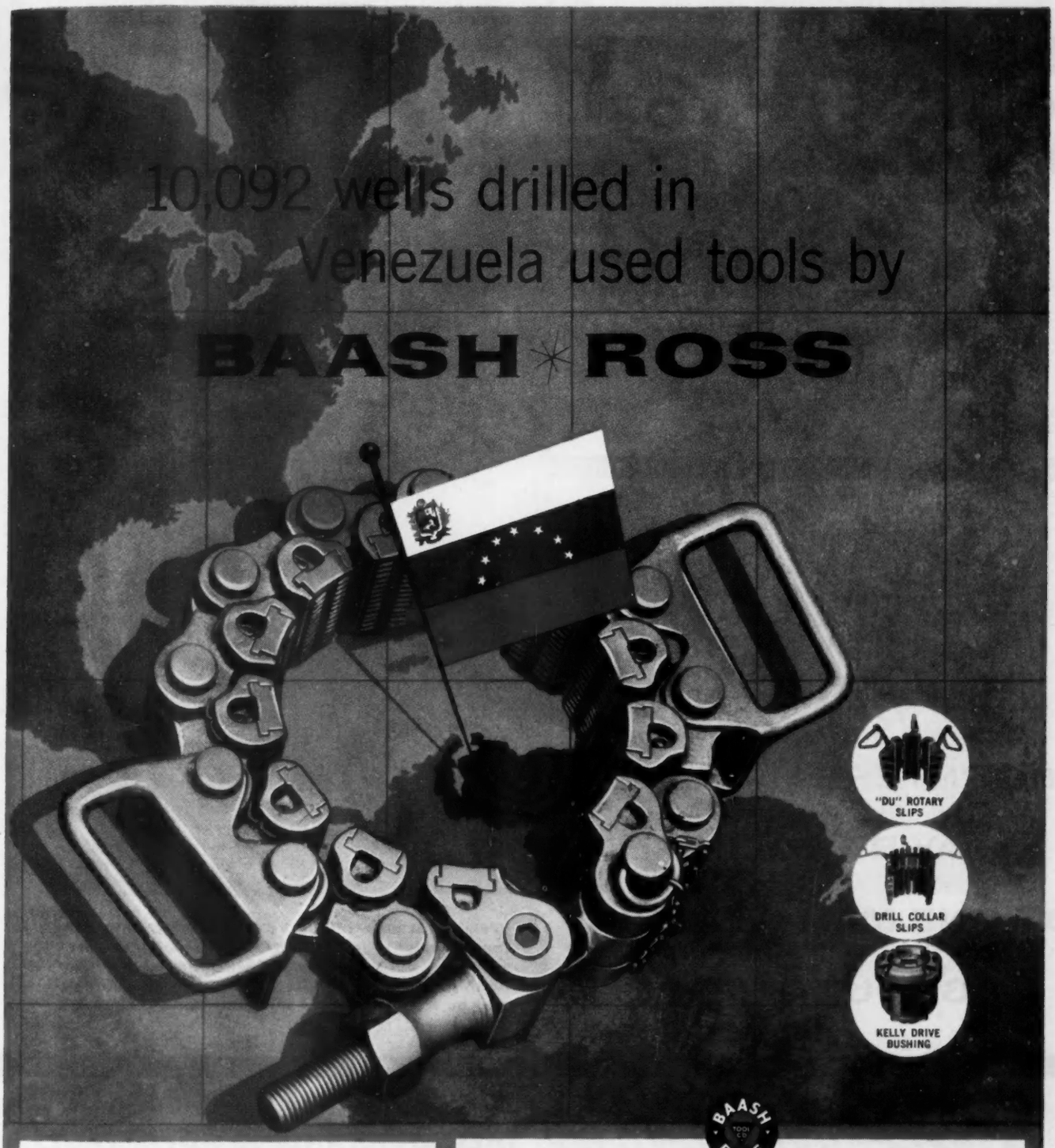

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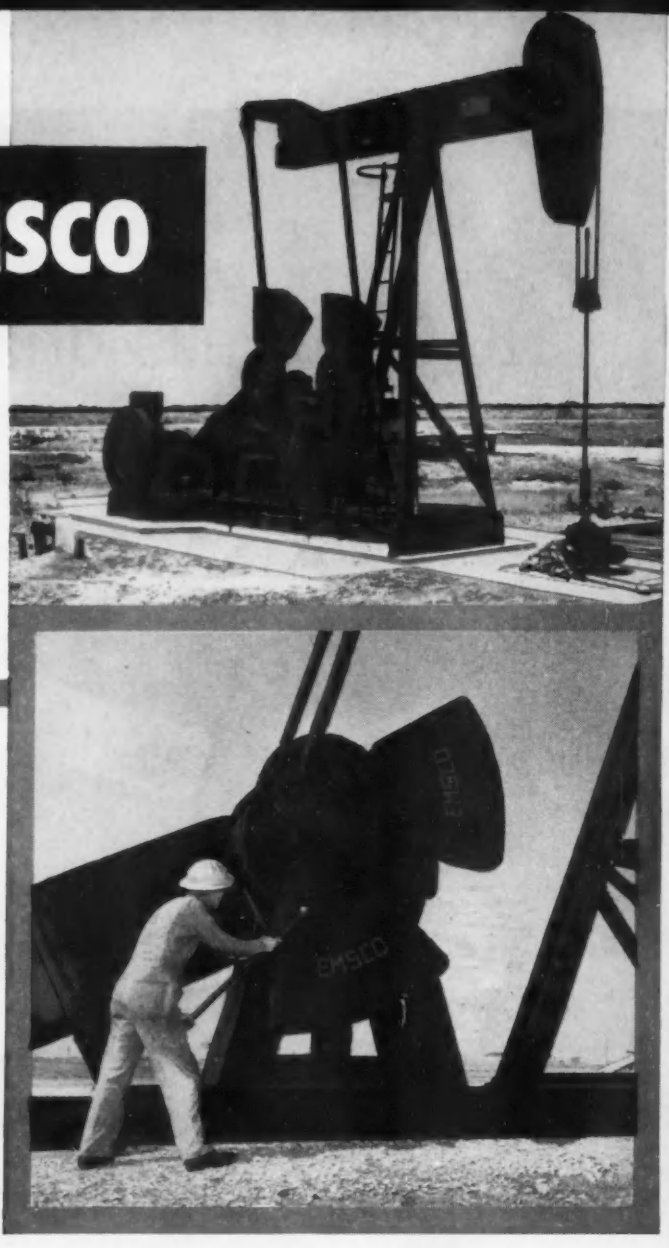

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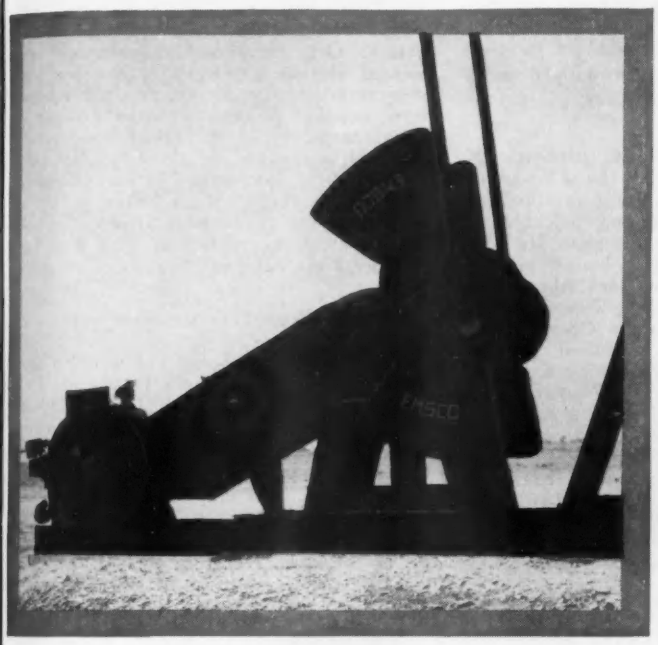
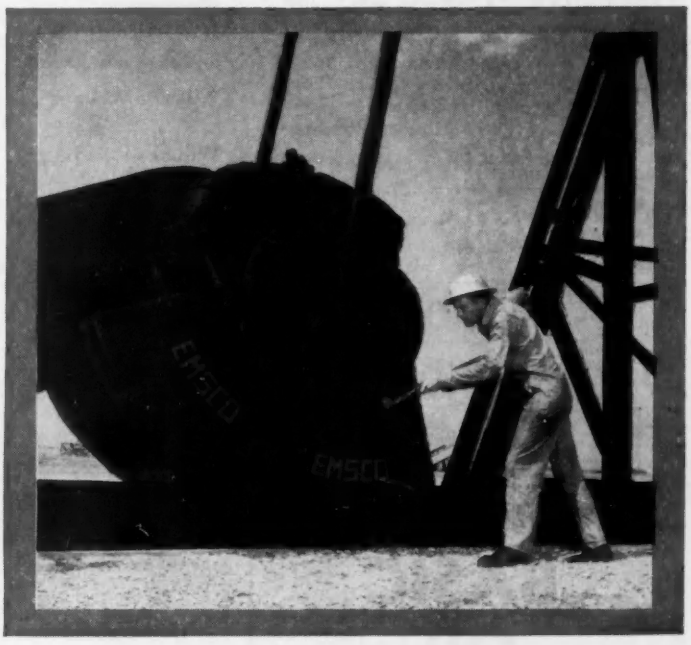
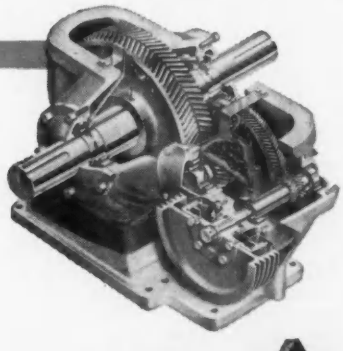


Disengage service brake. The upper counterbalance weight will cause unit to swing clockwise. Stop unit when weight has swung about 15° past vertical. Loosen clamping bolts and weight will swing to vertical position. Tighten bolts.



Repeat operation until weights are swung into the desired position. When weights are pivoted as far as possible maximum counterbalance effect is obtained. Adjustment markers are provided to facilitate operation.



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to district petroleum engineer. Veselka began working for Union as a petroleum engineer in 1948. He served in that capacity at Beeville, Refugio and Pettus until 1952 when he was transferred to the company's Tyler district and promoted to district petroleum engineer. He has been field drilling and production superintendent at Houma since 1955.

•

James M. Davis

James M. Davis has been appointed drilling superintendent in Okemah for **Reed Drilling Co.** Davis has been connected with the oil field business in Texas and Oklahoma. He has been with Reed for the past year, employed as a toolpusher.

•

Wilbur F. (Judge) Cloud, professor of petroleum engineering at the University of Oklahoma received in appreciation for his 31 years of service and teaching at O. U., a $3700 check recently. He also received a plaque and a bound volume of letters of appreciation. **Jack Abernathy,** a former student of Cloud's, vice president of the Big Chief Drilling Company of Oklahoma City and president of the American Association of Drilling Contractors, told of Cloud's service at a Petroleum Engineer's Club meeting in Oklahoma City. He was handed the check for $3700 by John Perry of the Lane-Wells Company. The check represented contributions of students and former students now in the oil business. Perry said there'll be another installment, or check, when other members of the oil fraternity are heard from.

•

J. D. Goodrich was appointed production manager of the Tulsa Exploration and Production area of **Shell Oil Company.** Goodrich will assume his new position in the spring of 1957 upon the completion of a special assignment in the company's head office in New York where he is now manager of Mechanical Engineering. In the interim, **A. G. Copeland** will take over as manager of Production, filling a vacancy created by the recent death of **W. H. Burke.** Copeland has been chief exploitation engineer of the Tulsa area for the past four years. He will be succeeded in that position by **R. E. Clark,** now production manager of the Kansas division. Goodrich joined the Shell organization in 1937. He has occupied numerous responsible engineering and production positions with the company in many parts of the country. He has served as chief mechanical engineer and before his transfer to New York in 1954 was division production manager of the North Texas division. Copeland joined Shell in 1936, and his entire career with the company has been devoted to exploitation engineering assignments in the Tulsa area. Clark joined the company in June, 1941. He has been division exploitation engineer, area reservoir engineer, and has held various other engineering assignments in the New Orleans, Midland and Tulsa areas.

•

Nicholas J. Campbell, Jr. has been named associate general counsel of **Standard Oil Company (New Jersey)** in New York. Recently Campbell joined Jersey Standard after having served Creole Petroleum Corporation as a director and vice president.

•

L. L. Sarchett

N. J. McGraw, vice president for economic development, **Shell Oil Company,** retired after 31 years service. **R. J. Sorenson** has been named assistant manager of the Shell head office personnel department. **L. L. Sarchett** has been named treasury manager of the Tulsa exploration and production area of Shell, replacing **G. A. Clark,** retired.

•

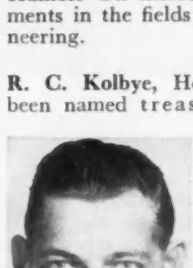
Reserve Oil and Gas Company has appointed **Harold F. Green** to the position of secretary of the corporation. Green has been assistant secretary of the company. He succeeds **W. M. Holloway,** vice president and secretary, who retains the title of vice president. Green is an attorney, admitted to the California Bar in 1941. Before joining Reserve as assistant secretary in 1954, he had been with a major California oil company for eight years.

•

Dr. Charles Van Berg has been appointed economics advisor to the executive representative of **International Petroleum Company, Limited,** in Bogota, Colombia. Dr. Van Berg served with the Humble Oil & Refining Company until his transfer to International Petroleum. His work with Humble Oil included a variety of assignments in the fields of economics and engineering.

•

R. C. Kolbye, Houston accountant, has been named treasurer of the **Commonwealth Oil Company** of Houston. He will serve in a similar capacity for the **Marine Gathering Company,** Commonwealth subsidiary which operates a gas processing plant in Lake Arthur, La., and a large diameter pipe line connecting the plant with producing gas wells in the Gulf of Mexico. Kolbye was formerly associated with Ada Oil Company. From 1949 until he joined Ada in 1954, he was with the national accounting firm of Arthur Andersen & Co.



R. C. Kolbye

•

Dr. Ellis K. Fields was appointed a group leader in the **Standard Oil Company (Indiana)** Research department at Whiting, Ind. Dr. Ellis is in the Organic Research Division and will work with others in exploratory research in the field of high octane hydrocarbons and petrochemicals. Dr. Ellis joined Standard Oil in 1950.

•

Harold G. Teverbaugh has been appointed vice president of **Texas Natural Gasoline Corporation.** In his new position, he will continue to devote the major part of his time to administrative and supervisory work for the Engineering and Gas department of Texas Natural. Teverbaugh joined

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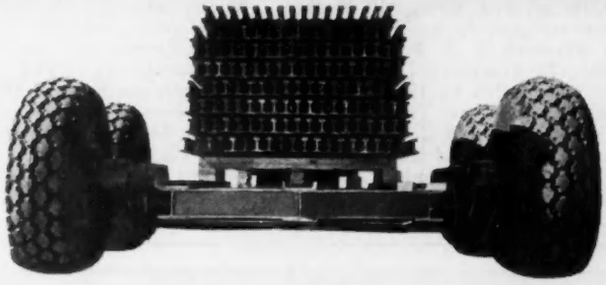

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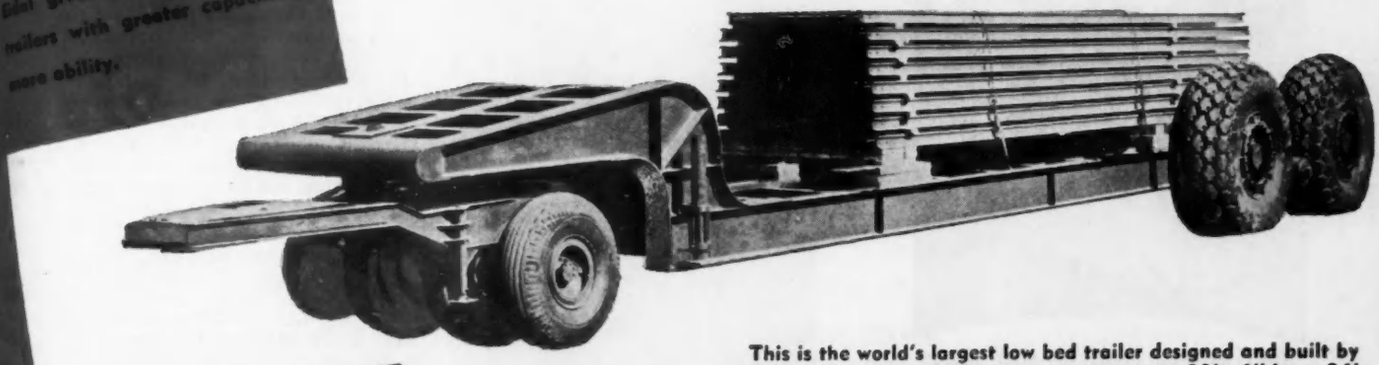

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Texas Natural in 1953 as assistant manager of the Gas division. He was later promoted to chief engineer, and in June, 1956, was made general superintendent. Before joining Texas Natural, he was associated with Stanolind Oil and Gas Company and Sunray Oil Company.

•

Allan C. Hamilton has been appointed treasurer of **International Petroleum Company, Ltd.** He succeeds **George R. Walker, Jr.**, who has resigned to accept a position with Esso Standard, S. A. F., an affiliate of Standard Oil Company (New Jersey) in France. From 1946 to 1951 Hamilton was associated with the Treasurer's department of Standard Oil Company (New Jersey) where he attained the position of senior foreign exchange analyst. In 1951 he became foreign exchange manager of Esso Export Corporation in New York and was transferred to London in 1953 to act as Esso Export's financial advisor. Hamilton joined the Coral Gables office of International Petroleum in October of last year.

•

Sun Oil Company appointed a regional office manager and three district office managers recently. **James P. Owens,** formerly office manager of Sun's Hamtramck, Mich., sales district, has been named regional office manager of the newly-established Empire State region headquartered in Syracuse, N. Y. The three district office managers are **Edward M. Winslow,** replacing Owens at Hamtramck in the Western region; **Lawrence E. Doughty,** to the Hartford, Conn., district of the New England region; and **George D. Soncha,** to the company's Newburgh, N. Y., district of the New York region.

DEATHS

A. L. Derby, 81, founder and former board chairman of the Derby Drilling Co., died December 24 at Wichita, Kan. He was active in oil developments near Chanute, Kan.; Casey, Ill.; Blackwell, Ponca City, and Newkirk, Okla. In 1920 he bought the Western Refining Co. and developed it into an integrated organization under the name of Derby Oil Co.

Fero Williams, 54, senior vice president, treasurer and a director of Tide Water Associated Oil Co., died December 24 in Manhattan Beach, Calif. He had been a Tide Water director since 1952.

Kenneth E. Thornton, 58, production superintendent for **Sinclair Oil & Gas Company,** died October 29, in a Tulsa hospital. He entered Sinclair service for the Mammoth Producing Corp., at Teapot Dome in an engineering crew in 1921.

Hiram Ward (Hi) Camp, 72, retired manager of the Cities Service Oil Co.'s Refining division, died October 29 in a Tulsa hospital. He retired in 1950 from the Cities Service firm after completing 33 years with the company.

Joe C. McConnico, 49, petroleum consultant of Oklahoma City, died November 5 in an Oklahoma City hospital.

W. H. McFadden, 87, died November 1 in Fort Worth. He was chairman of the board of Southland Royalty Co. and headed an oil royalty company which has properties in 12 states with new royalty acreage on 356,957 of its total of 1.8 million acres.

William Heaton Rinehart, who spent 40 years in oil well drilling, died in Damascus, October 2. He worked with Attock Oil Co., Ltd., Iraq Petroleum Company, and J. W. Menhall Drilling Co.

W. M. Vickery, 82, a director of The Blackwell Oil and Gas Co., and pioneer Oklahoma oil man, died November 13 in Blackwell, Okla.

Frank H. Thorne, chairman of Visco Products Company, Inc., Houston, and vice chairman of its parent company, National Aluminate Corporation, Chicago, died in his Riverside, Ill., home October 26.

Julio G. Bejarano, 54, manager of Shell Chemical Corporation's Denver plant, died October 24 in a Denver hospital. He joined Shell in 1926. His first job was as a designer in the Engineering department at the oil company's Martinez, Calif., refinery.

Arthur T. Roberts, former Socony Mobil Oil Company executive, died in a New York hospital last November. He had retired from Socony 10 years previously as director, treasurer and controller. He started in the oil business in 1907. In 1939, Roberts was elected to the board of Socony.

James A. Dowler, 80, of Bartlesville, Okla., retired superintendent of gas operations for Cities Service Oil Company, died November 24.

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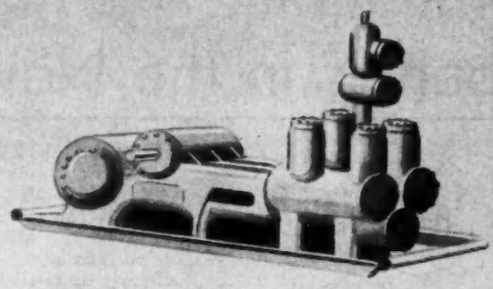

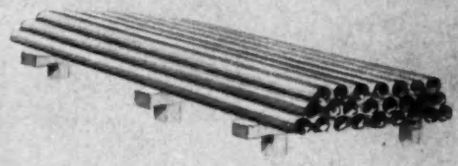

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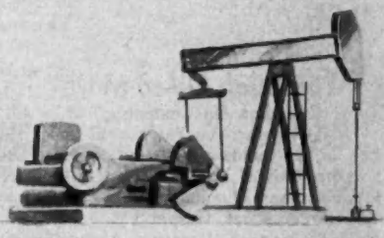

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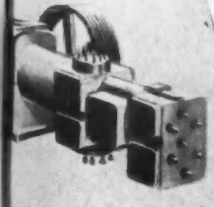

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Companies in the News

Canadian Oil to Move

Canadian Oil Companies, Ltd., will move its headquarters in Toronto in July, 1957, when its new building modelled after the Lever building in New York City, is completed. The new glass and aluminum structure, designed by architect Peter Caspari, is being built on the west side of University Avenue between Richmond and Adelaide streets. The new building will be 10 stories high and will have fully enclosed parking accommodations for 110 automobiles. Canadian Oil will move from their present address at 204 Richmond Street West and will occupy the top four floors of its new headquarters.

REITER-FOSTER OIL CORP. acquired 75 percent interest in 30 oil producing wells of **FRONTIER OIL COMPANY**, Wichita, Kansas. The gross production of the wells is a quarter of a million barrels of oil annually. Though the contract is effective immediately, oil runs from July 1, 1956, will be credited to Reiter-Foster. Frontier Oil will retain the option of drilling six additional wells within a year of the date of sale. Should these efforts be productive, Reiter-Foster will acquire such production according to engineering surveys of the primary and behind-the-pipe reserves, **Emil V. Hegyi**, president of Reiter-Foster said.

•

TEXAS PACIFIC COAL AND OIL COMPANY'S annual report to stockholders has received top honors in its classification from both the national financial weekly, Financial World and from the Texas Manufacturers Association. In its 16th annual international survey of corporate reports, Financial World rated the Texas Pacific report as best among independent oil companies. Over 5000 reports were considered this year in the international judging. A bronze "Oscar of Industry" was presented to **E. T. Adair**, executive vice president of the company, at the annual awards banquet in New York October 29. The Texas Manufacturers Association, which conducts an annual appraisal of Texas corporate reports, also rated Texas Pacific's report tops in its category. The award was made at TMA's annual convention in Fort Worth November 13. Consultants in preparation of the winning report were The Cain Organization, Inc., Dallas, Fort Worth public relations firm, and Georgeson & Co., New York financial analysts. The report featured a ten-year comparative summary of the company's position and results in oil and gas production, financial structure, leases owned and a summary of well completions by counties, fields and areas.

•

INTERNATIONAL MINING CORPORATION and **SUNSET OIL COMPANY** have been merged by agreement during a meeting of stockholders in Wilmington, Del., representing both firms. The new company will be called **SUNSET INTERNATIONAL PETROLEUM CORPORATION.**

•

PHILLIPS PETROLEUM COMPANY has established the Guymon district of its Production department with the office at Guyman, Okla. **Frank R. Holtzapple** has been named superintendent of the new district, which is part of the Plains division headquartered at Amarillo, Texas. **G. I. Freeze** is assistant district superintendent and **George Stevens** is district chief clerk.

•

O. F. WARREN EXPLORATION COMPANY, Tulsa, has organized a wholly-owned subsidiary, the **WARREN DRILLING COMPANY**, with **Jack B. Antry**, president. Other officers include **O. F. Warren**, chairman and principal chief executive officer and **Mrs. O. F. Warren**, secretary. All three are also directors of the new company.

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and this certificate is issued specifically for the purpose of bringing the said hose within the provisions of the above numbered contract to the above named Customer, and this certificate shall be valid and effective when executed by an officer of said Goodall Rubber Company.

The Goodall Rubber Company hereby unconditionally guarantees Goodall Rubber Co. Rotary Hose against failure due to any defect in workmanship and/or material for the period of one year from date of purchase. If at any time during the 12-month period from date of purchase, such Rotary Drilling Hose as identified by the Service Certificate should meet with accident under normal operating conditions, the Goodall Rubber Company agrees to:

A. Repair such hose without charge to the customer, other than transportation charges to and from the plant designated by the Company, provided in the opinion of the Company it can be made suitable for further use as Rotary Drilling Hose.

B. Convert any such Rotary Hose damaged by accident to such an extent that it cannot reasonably be made useable thereafter as Rotary Hose into as many vibrator hoses as possible, free of charge to the customer except for necessary additional couplings and freight to and from the specified plant.

WITNESS our signature at _____ on the _____ day of _____, 195__.

Accepted and Validated:
GOODALL RUBBER COMPANY

By _____
Title

_____
SUPPLY COMPANY

By _____
Title

Only Goodall offers this guarantee

The Goodall Guarantee shown above is one example of the Goodall way of showing their appreciation to the Drilling Industry. Goodall's success is due to the acceptance of their rotary hose by users all over the world. In order to keep their position at the top Goodall will continue to offer the finest product of its kind made—the Goodall Rotary Hose with the Barney Coupling—at competitive prices.

Goodall stays at the top because they have always pioneered a better product. Some examples are: the first high pressure rotary hose—the Barney Coupling—the Goodall repair service—the built-in safety clamp.

GOODALL RUBBER COMPANY

TRENTON, N. J.

GOODALL RUBBER COMPANY OF TEXAS: Houston, Odessa, San Angelo, Texas.
GOODALL RUBBER COMPANY OF CALIFORNIA: San Francisco, Los Angeles, Seattle, Salt Lake City, Portland.
GOODALL RUBBER COMPANY: New York, Philadelphia, Pittsburgh, Chicago, Denver, St. Paul, Detroit.
EXPORT: Goodall Rubber Company, Trenton, N. J.
STOCKING DISTRIBUTORS: Texas and Louisiana—Houston Oil Field Material Co., Wilson Supply Co., Hunt Tool Company, Heap Equipment Company; Iverson Supply Co.

A. P. I. CASING COUPLINGS
Short and Long, sizes 4½" through 13⅜". All thread: 8 round, ¾" taper

What's Happening

AMONG INDUSTRY ASSOCIATIONS

New York Nomads

New York Nomads Honor T. G. Schad of Asiatic

Last November the New York Chapter of Nomads held its last open party of 1956. The chapter honored T. G. Schad of the Asiatic Petroleum Corp. who will soon retire. John Baird, Baird Supply Co., Inc., acted in the capacity of toastmaster for the occasion. The chapter presented a leather golf bag and golf course umbrella to Schad.

The foreign visitors and guests present were C. M. Richardson, Creole Petroleum Corp.; D. Desei, Shell Oil Company; A. P. R. Church, Trinidad Oil Company; G. Cox, Creole; H. Rex Collins, Hydril Co.; and M. Garrison, International Drilling Company, N. V.

PESA Pacific Meeting To Be Held in Los Angeles

The Pacific district spring meeting of Petroleum Equipment Suppliers Association will be held February 6 at the Ambassador Hotel, Los Angeles, according to W. T. Powell, chairman of the Pacific district of the association.

The program probably will follow the pattern of previous Pacific district meetings which begin about 4 p.m., followed by cocktails at 6 p.m. and dinner at 7 p.m. No limit is being placed on the number who may attend from each firm and representatives from member firms in other districts also are welcome. Reservation requests, with checks for tickets at $12.50 each, should be made out to W. F. Pusch, special, Petroleum Equipment Suppliers Association, Pacific district, 639 South Spring Street, Los Angeles 14.

Compensation Change Made For Texas Drilling Workers

Texas drilling contractors were notified recently that a 7 cents per $100 payroll reduction in the manual rate for workmen's compensation insurance was approved by the state Insurance department at its annual rate hearings.

In a letter to members of the American Association of Oilwell Drilling Contractors, insurance consultant Joseph M. Shelton pointed out that the reduction in manual rate for the drillers contrasts with the 1.3 percent increase for oil classes generally. The rates are based on the previous two years' experience.

Estimating that savings for the statewide drilling industry will amount to $100,000 during the coming policy year, Shelton emphasized that "this saving has come about through the actions of contractors themselves in becoming more conscious of insured losses."

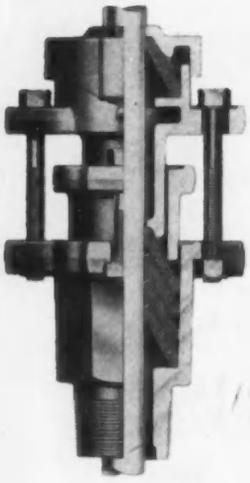
Angus McDonald, casualty actuary to the Texas Insurance Board, commended the drilling contractors' association for its nationally-recognized safety program, which was termed instrumental in reducing drilling accidents.

Tulsa Desk and Derrick Choose New Officers

The Tulsa chapter of Desk and Derrick elected the following slate of officers recently:

Judith Ross, Service Pipe Line Company, president; Marie Rogers, Aurora Gasoline Co., vice president; Marie Cooper, Public Service Company, corresponding secretary; Tenna Duncan, Finston & Company, recording secretary, and Beatrice Gaddis, Wheatley Co., treasurer.

New directors are Marie Ross, Arrow Drilling Company; Clara Langston, Bovaird Supply Co., Frances Frohnapfel, Sunray Oil Company; Norene Campbell, Kewanee Oil Company, and Eudora Benson, Service Pipe Line.



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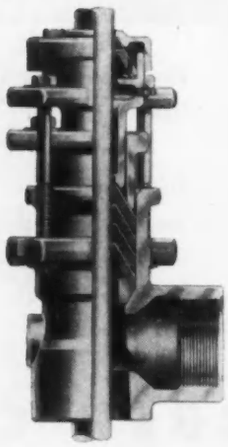
Hercules Stuffing Boxes
CAN END YOUR PUMPING WORRIES*

"REGULAR TYPE" DUPLEX POLISHED ROD STUFFING BOX

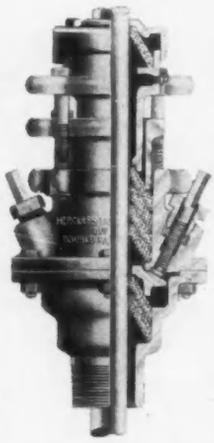
The old reliable, tried and proved on thousands of wells from coast to coast and in foreign fields.

HERCULES OIL RESERVOIR UPPER GLAND



"TEE BASE TYPE" DUPLEX POLISHED ROD STUFFING BOX

A combination Stuffing Box and Pumping Tee. Makes a short connection. Bolt lugs are placed low to eliminate fouling of elevator links. No bell nipple needed as top of body will support elevator. Full opening — unnecessary to remove body when pulling or running rods.



"TYPE DP" DUPLEX POLISHED ROD STUFFING BOX

A Double Packed Stuffing Box for use on high pressure wells and those that flow intermittently. Especially desirable for wells located near buildings, fire hazards of growing crops. Two compression bolts, in bottom sections, are tightened on Cone Rings to pack-off while replacing packing in upper section.

All HERCULES Stuffing Boxes are made of high grade malleable iron which prevents shattering if rods drop. They are tested to 3,000 pounds psi pressure and all use the famous HERCULES Split Cone Packing Rings.

* All HERCULES Stuffing Boxes may be equipped with Oil Reservoir Upper Glands on "problem" wells which pump-off and burn the packing. The polished rod moves through the oil in the reservoir which lubricates and cools it.

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GENERAL OFFICES AND PLANT TULSA, OKLAHOMA
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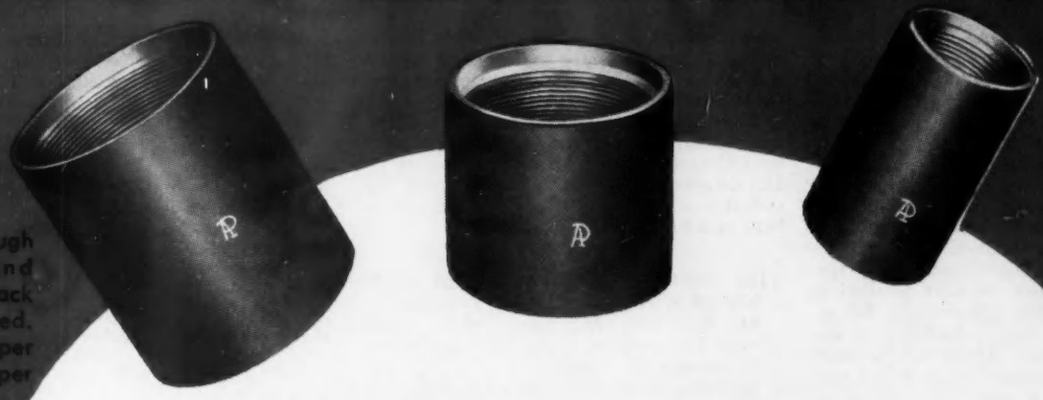
Short and Long, sizes 4½" through 13⅜". All threads 8 round, ¾" taper tapped per foot. Combination and sharp V thread casing couplings also available from stock.

A. P. I. TUBING COUPLINGS
Non-Upset sizes 1.900" through 4½". Upset sizes 1.660" through 4". Grades J-55, N-80 and P-105.

A. P. I. LINE COUPLINGS
...es ⅛" through ...", 14" and ...s" O.D. Black ...d Galvanized. ...cessed, Taper ...apped ¾" per ...ot.



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COUPLINGS

FOR THE OIL INDUSTRY

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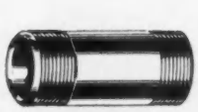
3000# and 6000# FORGED STEEL COUPLINGS
Manufactured to ASTM specification A-#105. Available in full and half couplings. 3000# sizes ⅛" through 4". 6000# sizes ⅛" through 3".

USE WITH THESE DEPENDABLE CAPITOL FITTINGS



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UNIONS

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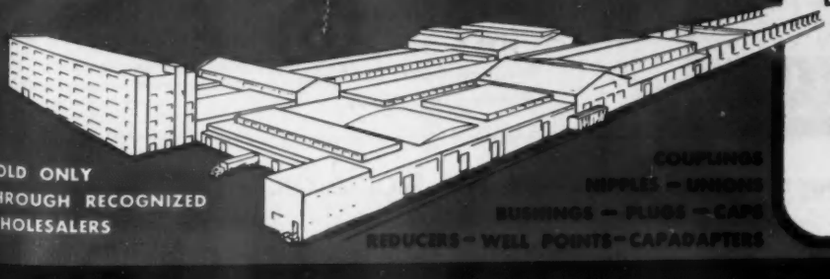
SOCKET WELD COUPLINGS AND CAPS

PRODUCERS OF QUALITY FITTINGS FOR MORE THAN 30 YEARS



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MFG. & SUPPLY CO.
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New Books, Maps and Movies

TEXAS OIL AND GAS, Texas Mid-Continent Oil & Gas Association, 311 South Akard, Suite 1800, Dallas 2, $25 per 100.

The Association's newest booklet is slanted for distribution to public officials, teachers, libraries, editors and other community thought leaders. Some of the chapter subjects are a history of Texas oil, the search for oil, Teaxs' part in producing, Texas natural gas and taxes.

Twenty-nine statistical tables in the back of the book list counties producing oil and gas, operating refineries in Texas, by counties, crude oil production—Texas and U. S., important Texas fields, marketed natural gas production in Texas and the U. S. and many others.

•

NATIONAL PETROLEUM BIBLIOGRAPHY, National Petroleum Bibliography, Box 3586, Amarillo, Texas, Annual subscription price, $35.

An advance edition of a completely new type periodical publication devoted to the petroleum industry is out, according to an announcement from National Petroleum Bibliography, publisher.

Designed for use as a desk top library file by executives, petroleum technologists and researchers, the National Petroleum Bibliography is a comprehensive bimonthly index of literature and data pertinent to all oil industry operations.

More than 400 publications per issue, predominantly technical and trade journals, are being indexed in the new bibliography, which also includes current books, technical papers, maps and various special publications of oil and gas agencies and institutions.

Bibliographical listings are indexed under the Uren decimal system, widely used by Oil companies in filing technical data. Information relative to all divisions of the industry is classified under specific numbers and headings.

•

THE INDUSTRY NOBODY REALLY KNOWS, Author, Craig Thompson, J. M. Halliwell, Manager, Public Relations Department, Gulf Oil Corporation, Pittsburgh 32, Penn.

Intended to explain the oil industry to the layman, this writing by a free-lance journalist, explains the problems and operations of several of the most essential phases of the industry, with emphasis on exploration. It helps explain away in popular language the popular myths that oil companies are huge octopi feeding on the public, that all oil producers are millionaires, that the depletion provision creates unearned wealth and that the industry as a whole is controlled or dominated by a few big firms.

•

OIL PRODUCTION HISTORY OF THE SOUTHWEST, Oil & Gas Department, Bank of the Southwest, P. O. Box 2629, Houston 1, Texas.

The new 88-page book is being offered by the bank to interested persons in the petroleum industry at no charge. The history succeeds similar literature published by the bank during the past few years, under the direction of Vice President Harold Vance, manager of the Oil and Gas department.

Principal oil-producing formations in Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma and Texas have been compiled in the history and a production history is given the 69 principal oil formations in the Southwest. This breakdown shows the name of the fields, locations, discovery dates, proved acreage, and production figures through 1954. Description of the formation geology is included.

•

TEN YEAR INDEX TO CORROSION, 1945-54, compiled by Norman E. Hamner and J. F. Van der Henst, Jr., National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas. $5, NACE members; $7.50, non-members.

The alphabetical subject index of Corrosion, monthly journal of the National Association of Corrosion Engineers, consists of approximately 4000 reference phrases and alphabetical author index of 1056 names. Titles are included of 629 articles published in the first decade of publication, 1945-54. Subject index is organized around the system developed for the NACE Abstract Filing Index. Data on pipe line and petroleum corrosion problems are in greater volume than other topics. Of special interest to corrosion engineers are numerous tables of data.

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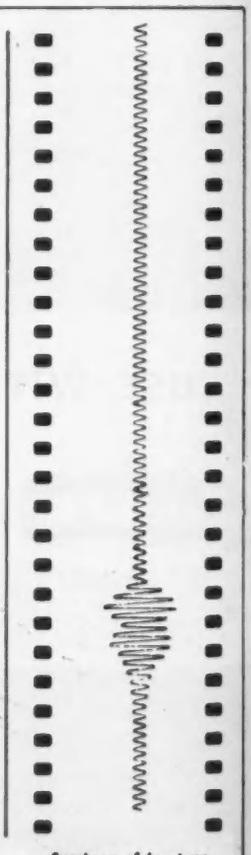
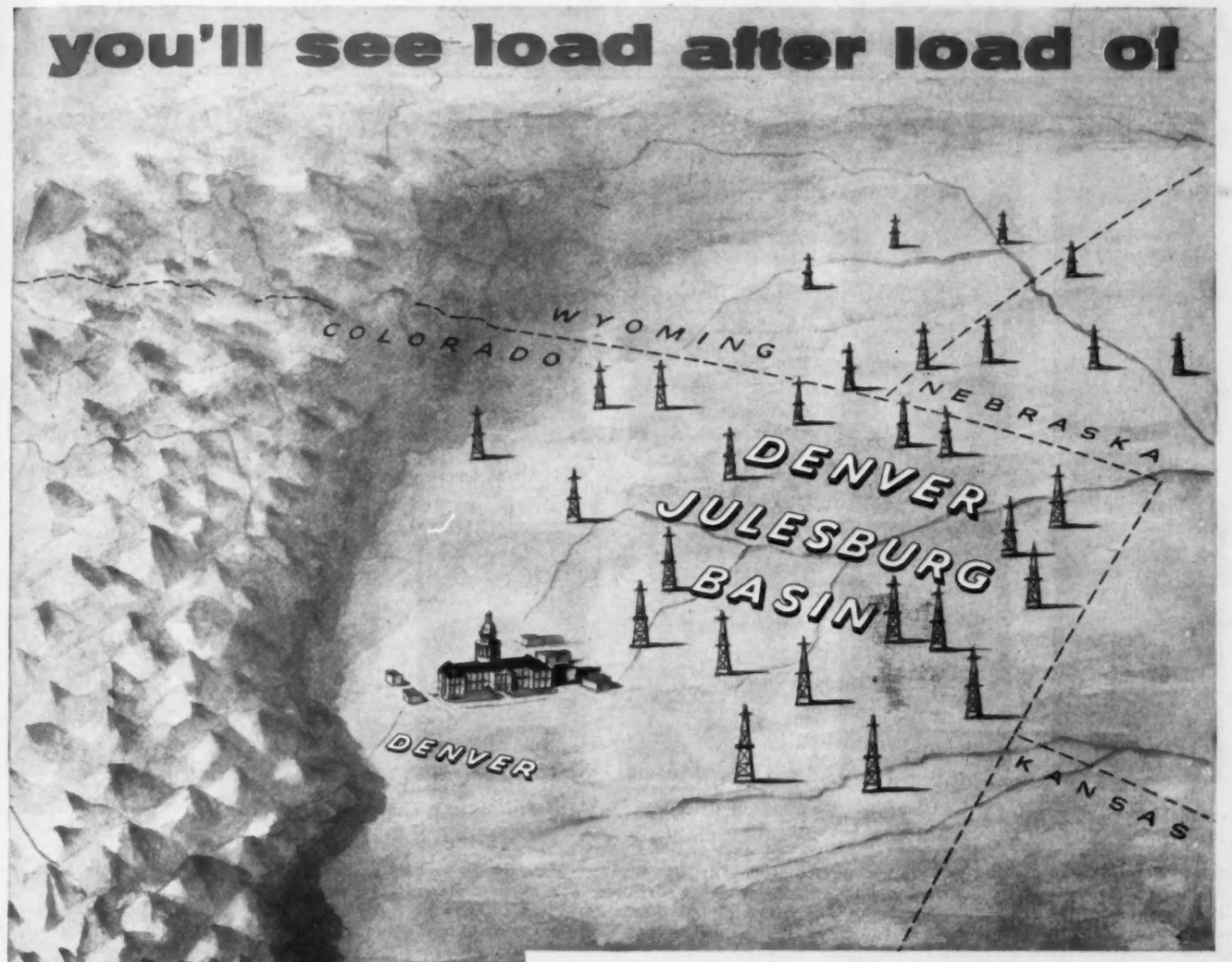


Specimen of log tape indicating saturation with break in zone

you'll see load after load of



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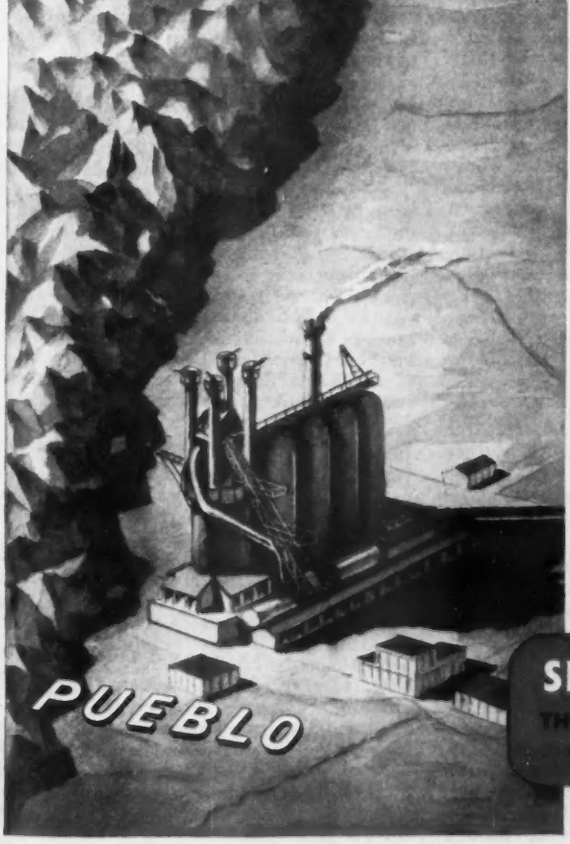
in the Denver-Julesburg Basin

There are good reasons for such acceptance. Every foot of CF&I Seamless Casing and Tubing is made under rigid quality controls to assure dependable service. And CF&I's mill at Pueblo, Colorado, is ideally located to give prompt, efficient service even on emergency rush orders. No wonder so many operators in the Denver-Julesburg Basin, and all over the West, depend upon CF&I Oil Country Goods!

Made to API STD 5A specifications, CF&I Seamless Casing and Tubing is available in popular sizes from 2⅜" through 9⅝" O.D.



3693

SEAMLESS TUBULAR PRODUCTS
THE COLORADO FUEL AND IRON CORPORATION
Denver, Colorado

CF&I

What's Happening

AMONG SERVICE AND SUPPLY MEN

Jack E. Gallian

B. C. Prowell

J. A. Vogle

Noble D. Lane

J. R. Osteen

Van H. Leichliter

Robert M. Greer

E. L. Alexander

Richard D. Boutros

James L. Ortner

Harold A. Bellows

Wilbur R. Shook

Continental Supply Company stores at Wichita Falls, Nocona and Sherman have been reassigned to the Oklahoma-Kansas division, under the direction of **R. A. Brewer**, division manager. **Jack E. Gallian**, district manager located at Wichita Falls, will enlarge his district to include Continental's Ardmore, Okla., sales office and supply stores located at Duncan and Healdton, Okla. The Oklahoma-Kansas division headquarters are in Tulsa. Continental's Rocky Mountain division headquarters will move to a new location and two new sales districts will be added to this division. **G. R. Pike**, division manager, will have new divisions headquarters at Denver, Colo. **B. C. Prowell** will step in as district manager for the newly created district located at Casper, Wyo. **J. A. Vogle**, formerly area supervisor in West Kansas, will take over the new district headquarters at Billings, Mont. Other appointments include **Rudd Seim** as district manager for the Tri-state area, with headquarters at Evansville, Ind. **Noble D. Lane** will be district manager for the new district office at Lafayette, La. **J. R. Osteen**, will become district manager at Continental's Corpus Christi, Texas, district headquarters.

•

Walter F. Munford, president, American Steel & Wire division, **United States Steel Corporation**, has been advanced to an assistant executive vice president of the corporation with headquarters at Pittsburgh. **Van H. Leichliter**, vice president in charge of operations, American Steel & Wire division, succeeded Munford as president of the division. Munford started with the Wire division as an open hearth helper in South Works, Worcester, Mass. After steady progress through the ranks, in 1942, he was named manager of operations of the Worcester district from which post he moved to assistant vice president in charge of operations three years later. In 1950 he became vice president to fill the vacancy created by the elevation of his superior, **Harvey B. Jordan**, to the presidency of the Wire division and in 1953 he became, in turn, president of the Wire division. Leichliter joined U. S. Steel in the metallurgical laboratory of the Wire division in 1930. He served as a metallurgist and later as superintendent of the wire mills at Cleveland's Cuyahoga works and at Worcester's South works. He became general superintendent at Worcester in 1945 and in 1950 he was named assistant vice president—operations at Cleveland. Leichliter was elevated to vice president, operations, in 1953.

•

Robert M. Greer, who has been serving as first vice president of the **George E. Failing Company** of Enid, Okla., manufacturers of portable rotary drilling rigs, has been named president and treasurer of the company. **E. L. Alexander**, former vice president of engineering and manufacturing, has been made first vice president.

•

Richard D. Boutros has been advanced from chief engineer to vice president and director of engineering at **Mixing Equipment Co., Inc.** Boutros had served as chief engineer since 1949. He joined the engineering staff of Mixing Equipment in 1946.

•

James L. Ortner was appointed comptroller of **United States Steel Corporation's** American Bridge division. He succeeds **S. P. Smail** who has resigned. He began his business career as an accounting trainee in Pittsburgh. He held various accounting posts with the corporation and with American Bridge and in 1950 was named general accountant for the Bridge division. In January, 1956, he was made assistant comptroller of U. S. Steel, the position he held at the time of his present appointment.

•

Worthington Corporation announced the election of **Wilbur R. Shook** as treasurer of Worthington succeeding **Harold A. Bellows**, who retired. Bellows served the company for 16 years as assistant treasurer from 1940-42 and treasurer since that date. He will continue as a consultant on pension and insurance matters. Shook has been assistant secretary of Worthington since 1947 and was previously associated with the New York law firm of Chadbourne, Hunt, Jaeckel and Brown. **Douglas H. Springer**, who has been a member of the Legal department since 1952, will succeed Shook as assistant secretary.

•

James E. Brown, a veteran of over 25 years in the wire business, has been named to the top post of **American Steel & Wire's Cyclone Fence** department of **United States Steel Corporation**. Since 1950, Brown has been general superintendent of the Waukegan, Ill., plant. At the same time, appointment of **Frank E. Kyndberg** to general sales manager of Cyclone Fence department was also announced. Kyndberg succeeds his brother, **Elmer Kyndberg**, recently deceased. Kyndberg will direct the activities of Cyclone's Sales department, operating throughout the country and selling chain-link fence. **Vernon L. Strohm**, a 33-year veteran of American Steel & Wire, and division superintendent of the Waukegan wire mill, succeeds Brown at Waukegan.

Ralph S. DeVault

J. B. O'Connor

H. N. Mallon

E. F. Shiels

W. F. Slater

Allan F. Schroeder

J. A. McCreery

A. J. Komich

Robert B. Kitzmiller

John W. McEvoy

A. R. Reinarz

Richard Cordrey

Ralph S. DeVault was appointed controller of **Delta Tank Manufacturing Co., Inc.** He served as assistant controller of Carrier Corporation's Bryant division at Tyler, Texas, for seven years before joining Delta Tank at its executive offices in Baton Rouge.

•

Dresser Industries, Inc., board of directors announced the elevation of the company's top officers to positions of new responsibility. **H. N. Mallon** has been named to the newly created position of chairman of the board and will remain as chief executive officer. **J. B. O'Connor**, formerly executive vice president, succeeds Mallon as president. Mallon has been associated with Dresser since 1929 when the company became publicly owned.

•

E. F. (Gene) Shiels was promoted to vice president of **Ideco**, one of the Dresser Industries. Prior to his appointment as vice president Shiels was domestic sales manager of Ideco and in his new capacity he will continue to direct the company's sales activities through branch offices and distributorships in various oil areas of North America. His career with Ideco began in 1945 when he became sales engineer for oil field equipment. Within three years he was appointed manager of Ideco's newly-formed Technical Service department and in 1951 became domestic sales manager.

•

W. F. Slater has been elected vice president for sales by the board of directors of **Kobe, Inc.** In 1940 he joined Kobe, manufacturers of the Kobe hydraulic oil well pumping system, and since 1948 has been general sales manager of the organization.

•

Allan F. Schroeder was appointed advertising manager for the **Caldwell Manufacturing Company** at Wichita, Kansas. He will be responsible for advertising and sales promotion of Cardwell products through its world wide organization. Schroeder joined the Cardwell organization 13 years ago. During that time, he has been responsible for a variety of phases of the company's operations.

•

Well Equipment Manufacturing Corporation has appointed **J. A. (Jim) McCreery** sales representative for Kansas. **Ted Stunkard,** Weco representative from Kansas, is being transferred from Great Bend to Oklahoma City to serve southern Oklahoma, including Oklahoma City. **Charley Gisler** will remain in Tulsa as sales representative for northern Oklahoma. The establishement of a second sales territory in Oklahoma enables Weco to provide better service throughout the entire state. McCreery will be responsible for the sales of Weco unions, blocks and compounds, as well as Chiksan swivel joints, steel rotary hose and mud guns.

•

Robert B. Kitzmiller has been named Los Angeles district sales manager and **A. J. Komich** has become gas products manager of **Rockwell Manufacturing Company's** Meter and Valve division. Kitzmiller, formerly gas products manager with headquarters in Pittsburgh, joined the company in 1934 as production clerk. He was made a sales engineer in the Pacific Northwest in 1945 and became San Francisco branch sales office manager in 1951, district manager the following year and gas products manager in 1955. Komich, who joined Rockwell in 1946 as a sales engineer in the Boston district office, was named gasoline and oil products supervisor for that office in 1951. He moved to Pittsburgh as assistant product manager early this year.

•

American Hoist and Derrick Company recently announced that **John W. McEvoy** has been appointed vice president and general manager of the **Lebus Manufacturing Company,** a new wholly owned subsidiary of American Hoist, located in Longview, Texas. McEvoy, a veteran employe with 17 years of service, was formerly works manager of the American Hoist plant in South Kearny, N. J., and more recently superintendent of structural works in the St. Paul plant.

•

A. R. Reinarz has been promoted to chief engineer and **Richard N. Cordrey** to assistant chief engineer at the Toledo, Ohio, plant of **The National Supply Comany.** Reinarz joined the company in 1937. He worked out of Houston, Texas, as a field engineer for the Toledo plant. He was transferred to Toledo in 1954 and was named administrative engineer. In his new position he succeeds **H. L. Willke,** recently named assistant director—engineering at the company's general headquarters in Pittsburgh. Cordrey started with the company in 1944 and has engaged in development and production work on the company's drilling rigs. He was named chief designer in 1954.

•

Walter L. Brough, who has been serving as assistant to the president since joining the organization two years ago, has been promoted to the office of executive vice president of **Hercules Motor Corporation,** manufacturer of gasoline and diesel engines, at Canton, Ohio. He formerly was associated with the Timken Roller Bearing Co. and the Central Alloy Division of Republic Steel Corp., before joining Hercules Motors Corporation. Joining the Timken organization in 1937, he served there in various capacities in plant operation and engineering until 1953 when he joined Republic Steel.

•

Schlumberger Well Surveying Corporation made five new division and district assignments and promotions. **Wilbur D. Ford** is the new Kansas division sales manager at Wichita. He previously served at Wichita, Russell and Ardmore. **H. F. Sorensen,** formerly Schlumberger district manager at Sterling, Colo., assumes the same position at Fort Morgan. He has worked as field engineer in Pennsylvania, Illinois and New Mexico. **Noble Ellis** has been promoted to field sales engineer at Lafayette, La. He joined Schlumberger in 1950. The new field sales engineer at Roswell, N. M., is **Robert S. Beaty.** He joined the company in 1950 and has served as field engineer

in several locations. **L. D. Thomas** has been named manager of Schlumberger's district office at Duncan, Okla. He was employed by Schlumberger in 1950.

R. C. Gann

H. B. Wilson

Reed Roller Bit Company division manager changes were recently announced. **R. C. Gann,** former Eastern Sales division manager, has been transferred to Reed's Oklahoma division as its new manager. Replacing Gann in the Eastern division, is **H. B. Wilson,** former division manager in Canada. **M. F. Wright,** special salesman in Oklahoma, has been named Sales division manager in Canada. Gann has been with the Reed organization over 15 years, all of which has been spent in the Eastern Sales division. Wilson was employed by Reed from 1935 to 1942 as a salesman in Oklahoma and Illinois. In 1948, he was located in the Texas Gulf Coast division until his appointment as Canadian Sales division manager in 1952. Wright began with Reed in 1937. He has spent all of his time with Reed in the Oklahoma area with the exception of a brief stay in the Houston office as sales training supervisor.

M. F. Wright

•

Schlumberger Well Surveying Corporation, has announced the appointment of **Everett F. Stratton** as vice president of operations for the corporation. He succeeds **D. C. McCann** who has been named president of the corporation's subsidiary, **Johnston Testers.** Stratton joined Schlumberger in 1936 as a field engineer and, a year later, was promoted to manager of the Illinois division. In 1945, he returned to Houston to head the Sales department and was later transferred to Denver as manager of the Rocky Mountain area. In 1950, Stratton again returned to Houston as southwest area manager, the position he held until his new appointment as vice president of operations. **Louis E. Magne** assumed the position of Southwest area manager with headquarters in Houston. He was formerly South Texas division manager in San Antonio. **William R. Mills** has been transferred to San Antonio as South Texas division manager, replacing Magne. **Wm. M. Pickles, Jr.,** has been named administrative assistant to **W. J. Gillingham,** executive vice president of Schlumberger. Pickles will coordinate the manufacturing, material and plant maintenance activities of the Corporation. Pickles was formerly assistant manager of operations.

Power Plant to Be Installed By Stewart & Stevenson, Inc.

A Diesel Electric power plant with an electrical output capacity big enough to furnish all of the electricity for an average town of 30,000 people has recently been completed by Stewart & Stevenson Services, Inc., of Houston. The Diesel power plant equipment is to be installed by Stewart & Stevenson engineers in a locality so remote that a unique job of precision prefabrication was required prior to shipment of the equipment. In fact, the erection of the complete equipment had to be carried out at the Houston plant of Stewart & Stevenson before any part of the final assembled units could be shipped.

The cooling system, the exhaust system, the starting equipment and all of the piping had to be prefitted in Houston so that after arrival at the final destination, the complete power plant facility could be set up and placed in operation utilizing prefitted equipment and tooling incorporated within the shipment.

Not only were there limitations as to assembly, but time also provided another important factor. Stewart & Stevenson engineers had to meet rigid completion schedule and all parts were shipped by air.

Since the project represented a complete "turnkey" job insofar as the Diesel generator sets were concerned, Stewart & Stevenson had to first design and lay out the power plant arrangement, fabricate huge steel sub-bases and unitize as well as text the complete equipment prior to shipment.

After complete assembly and test in the plant of Stewart & Stevenson in Houston, each unit was then completely dismantled and boxed in export containers also built by Stewart & Stevenson especially for shipment of the heavy machinery aboard aircraft. This portion of the project is now complete and the 5000 kilowatt power plant is either on location or on its way by special air transportation.

To insure proper installation and erection of the units, there are three specially trained Stewart & Stevenson engineers who will supervise the complete erection of the power plant equipment and place it into service.

Stewart & Stevenson cannot at this time disclose the destination of the power plant equipment or the customer involved.

Texas Instruments, Equitable Life Announce $10 Million Transaction

Texas Instruments Incorporated announced that it has entered into an agreement to sell $10 million in notes due between 1959-1971 to The Equitable Life Assurance Society of the U. S.

Texas Instruments President J. E. Jonsson said that about $4 million of the proceeds will be used to construct the first building on the company's 296-acre North Central Expressway tract. The remainder of the funds will be used to refinance the company's first mortgage bonds and to increase working capital.

The Semiconductor-Components division —leading producer of germanium and silicon transistors and other electronic components—will occupy the new 238,000 square foot building when it is completed in 1957. The Apparatus division, which designs and manufactures complete electronics systems, and Geophysical Exploration division administration will continue to occupy the main Dallas plant at 6000 Lemmon Avenue.

Lesson in Loading

International Drott TD-14 Skid-Shovel loads a Model S-164 International dump truck in a typical industrial application. Greer instructors, shown in white coveralls, guide students through proper loading procedures.

"Joseph Zeppa" Drilling Tender Put in Commission by Delta

The drilling tender "Joseph Zeppa" was placed in commission by the owner, Delta Marine Drilling Company, following a christening ceremony at American Marine Corporation (formerly Alexander Shipyard) recently.

The "Joseph Zeppa," named after the president of Delta Marine, represents the first tender of its type for that company and also the first large piece of offshore equipment completed by the yard since it changed its name.

A converted LST, the tender is a non-self-propelled vessel, 328 feet by 50 feet by 28 feet, and was reconstructed, equipped and outfitted in strict accordance with the requirements of the American Bureau of Shipping, the U. S. Coast Guard and the Public Health Service for drilling in the Gulf of Mexico.

The principal feature of the tender is that all light and power is supplied to the tender and the drilling platform by an A. C. electrical system. On the tender itself are installed the main power plant, the main mud pumps, active and reserve mud pits, all drilling fluids, evaporator unit, Halliburton unit, bulk mud, cement and chemical storage.

Herb J. Hawthorne, Inc. Wins House Organ Award

"Doodlebugger Doodles," company paper published monthly by Herb J. Hawthorne, Inc., Houston exploration bit manufacturing firm, received an Award of Merit from the Society of Associated Industrial Editors at the annual SAIE Convention in Dallas.

The award was made in recognition of exceptional accomplishment of purpose, excellence of editorial content and effectiveness of design in the external company newspaper division.

Edited by Earl M. Weaver, as part of the company's customer and public relations program, the publication is distributed throughout the world to some 8000 fieldmen in the seismic, minerals exploration and water well drilling industries.

The award was accepted by John E. McGary, executive vice president of Brennan • McGary • Robinson, Inc., Houston advertising agency which integrates the Hawthorne advertising, sales promotion and public relations program.

Over 500 publications were submitted in the annual competition, from member companies throughout the U. S.

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H. K. Porter to Construct 17-Story Pittsburgh Building

H. K. Porter Company, Inc., announced plans to have constructed a 17-story office building at Sixth Avenue and Grant Street, Pittsburgh, according to T. M. Evans, Porter's president. The general offices of the Porter Company will occupy approximately six floors of the proposed building and the balance will be rented to other tenants.

Harrison & Abramovitz, New York architects, who designed the Alcoa and Mellon-Steel buildings, have been engaged as architects for the proposed building which, it is expected, will be ready for occupancy by mid-1958.

Evans stated that the company was prompted in its decision to undertake having the building erected as a head office in Pittsburgh by several factors. First, he said, that for an industrial concern like the Porter Company the redevelopment of Pittsburgh since World War II, together with its growing importance as an industrial research center, made it an ideal location for the company's general offices. He stated further that for a city of its size, as a market for industrial products, the Pittsburgh area was second to none.

Evans also pointed out that the need for modern office space is acute in the business center of the city since existing buildings such as the Gulf, Koppers, Alcoa, and Mellon-Steel are used primarily by the companies owning them.

The building will be covered in metal, probably aluminum or stainless steel. It is planned that the heating and cooling system will be contained in the radiant-type grid ceiling, and the windows will be vertically pivoted, reversible, similar to those in the Alcoa building, which will make offices on the very lowest floors as quiet as those on the top floor of the building.

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American Hoist and Derrick Starts West Coast Operation

American Hoist and Derrick Company of St. Paul, Minn., announced that the firm has expanded its operations to the West Coast. A totally owned new corporation, American Hoist Pacific Company, has been formed with headquarters in Seattle, Wash.

Charles D. Gould

The new firm will primarily produce special custom-engineered heavy materials handling equipment that is not normally offered by American Hoist. This special equipment in many instances will incorporate certain component parts and assemblies now used in standard American Hoist products. Major markets to be served on an international basis will be power plants, offshore drilling, specialized construction and transportation. A special emphasis will be placed on certain types of extra ordinarily high capacity lifting devices employed in the testing of nuclear weapons.

Charles D. Gould has joined the new corporation as vice president and general manager. Formerly an employe of American Hoist, he was executive vice president of Colby Steel and Manufacturing Company, Inc., of Seattle, Wash., having spent about 17 years with that firm and its predecessor.

Other officers of American Hoist Pacific are John E. Carroll, chairman of the board, and R. J. Stoddard, president. Harry Bratt, formerly assistant chief engineer at American Hoist in St. Paul, will move to Seattle to join the new corporation as vice president in charge of engineering.

Welex Jet Extends Services To Four Corners Area

Jack H. Smith, manager of the Rocky Mountain division of Welex Jet Services, Inc., announced the opening of a new servicing location at Cortez, Colo. The new district office will serve oil producers in the Four Corners area.

Jack E. Brown

The new Welex office in Cortez, is the fourth location of the company to be opened in the Rocky Mountains. Other locations include Farmington, N. M., Fort Morgan, Colo.; and Kimball, Neb. The Rocky Mountain division office is in Denver.

Manager of the new district is Jack E. Brown, who was transferred to Cortez from the Farmington district where he served as assistant manager. Prior to moving to Farmington, Brown was a research engineer in the Welex Research department and in Houston worked as a rigman.

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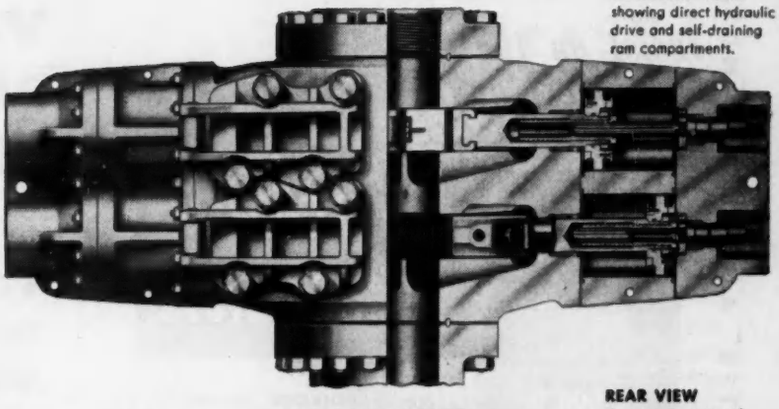
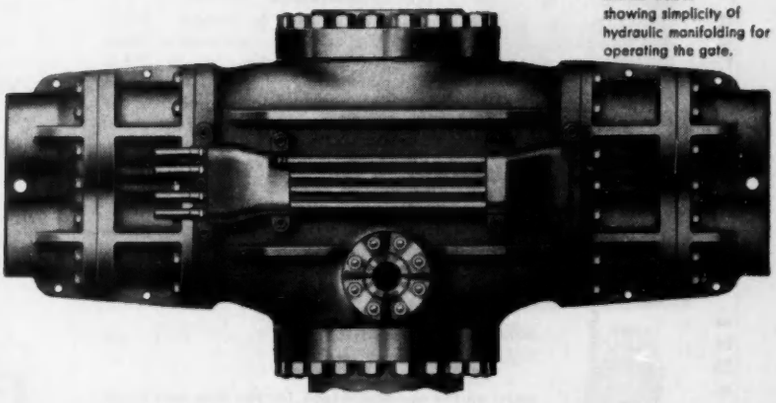
Before you make your next investment in cellar control gates, take a moment to think through the various features you would like to have in those gates. You want protection, of course, but protection alone is only *part* of the story. You want such other important advantages as *Compactness . . . Simplicity of Ram Changes . . . Minimum Maintenance . . . Maximum Versatility* . . . and many others.

Then check ANY cellar control gate against the *multiple* advantages you get in Shaffer Hydraulic Cellar Control Gates and you'll see why Shaffer Gates are the top choice of leading operators throughout the oil industry. No other equipment offers *so many* design and performance features—in such a compact "package" as do Shaffer Hydraulic Gates.



CUTAWAY VIEW showing direct hydraulic drive and self-draining ram compartments.



REAR VIEW showing simplicity of hydraulic manifolding for operating the gate.

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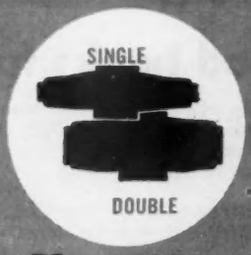
To begin with, Shaffer Hydraulic Gates are amazingly compact in all three dimensions—height, width and length. Even in sizes as large as 13⅝" (12" Series 900), Shaffer Hydraulic Double Gates require only 30" total height—Single Gates 18½". In addition, there's no need to allow extra space above or at the ends in order to change rams, because Shaffer's exclusive side-opening doors through which the rams are changed open on the dimension where there's plenty of room. Thus, Shaffer's compactness is completely useable compactness!



You get
SINGLE or DOUBLE DESIGN

Some operators prefer Double Gates (two ram compartments unitized into one body) for their greater compactness in a multiple gate hookup. Others prefer the extra flexibility of Single Gates (use them singly . . . in pairs . . . or with a Double Gate for three-way protection). From Shaffer you get what YOU prefer—Double or Single—with both designs offering the same basic operating and construction features!

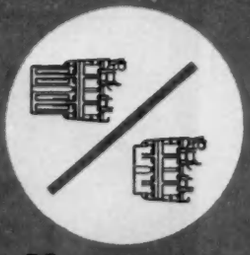
You get
EASY RAM CHANGES

To meet requirements of varying pipe sizes as wells are drilled, the rams must be changed frequently. Shaffer Gates are unsurpassed in the ease with which the rams can be changed. Simply unbolt and open doors in the side of the gate body, slide out the ram assembly, change rams, slide the assembly back in place and bolt the doors shut. It's that simple.

What's more, rams can be changed with equal ease whether the pipe is in or out of the hole!

You get
SELF-DRAINING COMPARTMENTS

You want a gate where no detrimental mud or sand can accumulate to interfere with free ram travel—and Shaffer gives you this advantage, too. Note how the rams travel on guide ribs high above the steeply-sloped gate bottoms. Mud and sand quickly drain back into the well. Also, since well pressure is free to flow to the back of the rams, it actually assists in the closing and sealing action!



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Do you prefer the quick indication of ram position provided by a Rising type of Locking Shaft? . . . Or do you prefer the greater compactness of the Non-Rising type of Locking Shaft? Take your choice—from Shaffer you can get the particular type that best meets your particular requirements!

THESE ARE ONLY PART OF THE COMPLETE SHAFFER STORY on design and operating advancements . . . advancements backed by the organization that pioneered cellar control gates more than three decades ago. Successful from the first gate built, Shaffer Gates have nevertheless gone through a continuous program of development that has kept them always ahead of the industry. That's why you get more features—plus operating flexibility to meet *your particular preferences*—when you specify SHAFFER. See your nearest Shaffer representative for further details—or write direct!

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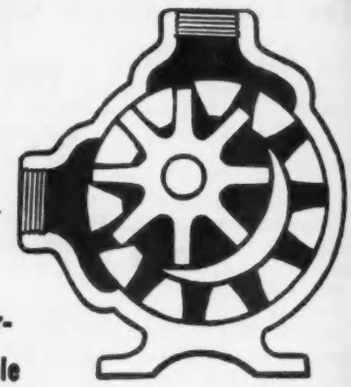

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Beaird Completes Merger With American Machine

J. B. Beaird Co., Inc., of Shreveport, La., and American Machine & Foundry Co. have merged interests with a 15 to 1 transaction of stock involved. Beaird traded 10,000 shares for approximately 155,000 shares of American Machine.

The J. B. Beaird Co. will continue to do business under its present name. No changes in operating policy or personnel are contemplated, Beaird officials said. The present officers of the local firm will be retained.

J. Pat Beaird is president and general manager of the Beaird firm, and Charles T. Beaird is vice president and assistant general manager.

Morehead Patterson is president and board chairman of the 56-year-old AMF company. His vice chairman is Gen. Walter Bedell Smith. AMF operates some 36 plants and five research and development laboratories in the U. S. and foreign countries.

Dorr-Oliver Incorporated Forms Australian Subsidiary

Dorr-Oliver Incorporated announces the formation of Dorr-Oliver Pty., Ltd., a wholly-owned subsidiary in Australia. Beginning on January 1, the new company began the design, marketing and servicing of the complete line of D-O equipment for metallurgical, chemical and industrial usage and for the sanitary field of sewage disposal and water treatment in the Australia-New Zealand area. This new Australian organization becomes the ninth Dorr-Oliver Associated Company.

D. U. Macintosh, associated with D-O activities in Australia since 1933, is managing director of the company. Hobart Duff Pty., Ltd., who have represented D-O interests for the past 27 years, will continue as such for the balance of 1956. W. V. Hobart Duff, managing director of Hobart Duff Pty., Ltd., will serve on the board of Dorr-Oliver Pty., Ltd., and act as adviser-consultant to the new company. Manufacture of D-O equipment will remain in the same hands as before.

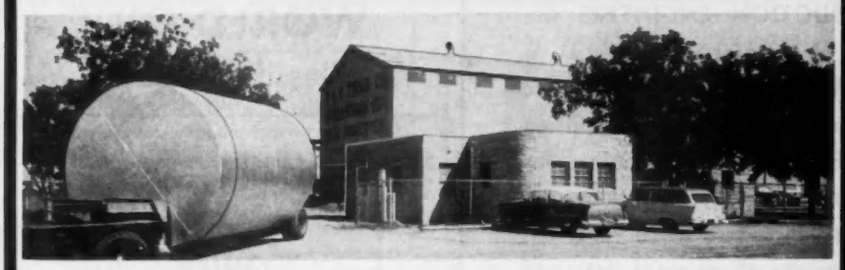
Schlumberger Gives Scholarships To Two Canadian Universities

Schlumberger Well Surveying Corporation has made two scholarships available to Canadian universities. The University of Manitoba and the University of Saskatchewan were chosen this year. Each of the scholarships is worth $500 with a matching grant going to the university.

Fox Adds 7 Branch Offices In Eastern, Southeastern Cities

Seven new branches were opened in eastern and southeastern cities during 1956 by The Foxboro Company, Foxboro, Mass., manufacturers of industrial instruments. The company's total number of offices totals 52.

In the twelve-month period, the following eastern offices were opened and sales engineers assigned: Augusta, Maine, J. G. Bravacos, sales engineer; Richmond, Va., G. E. Clark, branch manager; and North Tonawanda, New York, J. G. Dobson, branch manager. In the southeast: Chattanooga, Tenn., W. H. Rhyne, sales engineer; Pensacola, Fla., R. F. Sutton, Jr., sales engineer; Tampa, Fla., F. J. Stevens, Jr., sales engineer; and Memphis, Tenn., D. C. Rosser, sales engineer.



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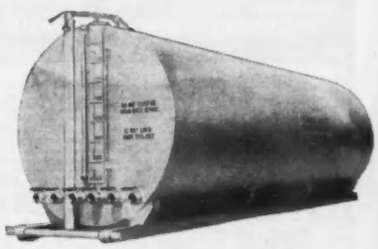

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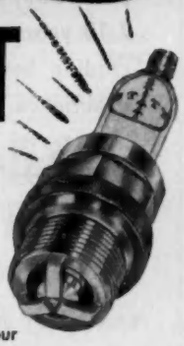

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For more information on advertised products, use the Readers' Service Postcards opposite the last page in this issue.

Link-Belt Acquires Shares Of Detroit Power Screwdriver

Link-Belt Company has acquired Detroit Power Screwdriver Company, manufacturer of power-driven screwdrivers and related automated assembly equipment. Link-Belt acquired all of the shares of the Detroit company through the exchange of 20,020 shares of Link-Belt common stock on the basis of 2½ shares of Link-Belt for each share of Detroit Power Screwdriver Company.

"Joining the products and engineering facilities of Detroit Power Screwdriver to Link-Belt Company will increase the sales potentials of both," Robert C. Becherer, Link-Belt president, said. "The Detroit company's line adds to Link-Belt's materials handling equipment a further phase of automated equipment, to serve industry better in the ever expanding field of assembly automation."

Becherer said the Detroit company has 95 employes and will be operated as a subsidiary by its present management which is headed by Roy W. Bailey, who, with his associates, founded the enterprise in 1926.

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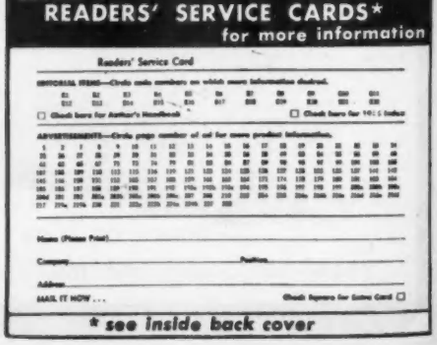

***see inside back cover**

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Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties, from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire, or call collect for further information.

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Due to the recent death of one of the owners of Threeway Drilling Company we have decided to sell our rotary drilling rigs. We have two exceedingly well kept Bethlehem drilling rigs fully equipped for drilling in the Permian Basin. If interested please contact Mr. Charles I. Francis, Mellie Esperson Building, Houston, Texas, or Mr. J. K. Hazlip, Box 824, Midland, Texas.

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A graduate mechanical engineer with production or well completion experience needed. Job will require design work and some travel. Headquarters in Houston—Reply

Box 122-W
WORLD OIL
Houston, Texas

■ SEISMOLOGIST with 5 years foreign and domestic experience desires position with major or independent oil company. Wide experience—California, Gulf Coast, Peru, Venezuela, Colombia. Geology Degree. Available February 15, 1957. Box 121-W, WORLD OIL, Houston, Texas.

■ SEISMOGRAPH FIELD SUPERVISOR wanted by French geophysical corporation expanding its operations mostly in Europe and Africa. Thorough evperience in all phases of seismic field techniques needed, with 8-10 years' field practice if possible. Preferably age 30-36. Furnish resume of education and experience. Box 120-W, WORLD OIL, Houston, Texas.

■ DODGE 1950 Power Wagon, 4-wheel drive, winch, aluminum seismic cab, Butane heater and tank, excellent mechanical condition, 9,000 miles. National Exploration Laboratories, 3309 Winthrop, 209-12 Ridglea State Bank Building, Fort Worth 7, Texas.

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Attention Contractors
FOR SALE

1—General Motors Oilfield Quad, Rebuilt
1—General Motors Oilfield Twin, Rebuilt Diesel or Gas Powered Generator Sets Catheads, Automatic, Used
1—40" Parkersburg Hydromatic Brake, Used
1—Wilson Titan w/Transmission, Excellent.

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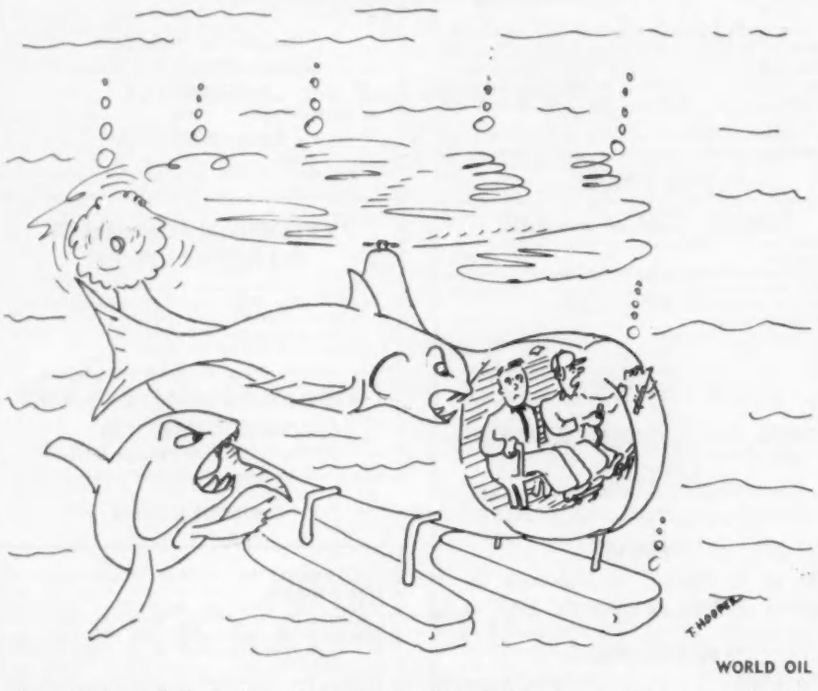
Don't Cost . . . . They Pay

Laugh Anyway

The editors' hair grows gray;
His fingertips grow sore,
Yet some so-and-so is bound to say,
"I've heard that joke before."



"Danged, lousy Gulf weather. I know that landing platform is around here somewhere."

Cause of Death

"I knew a man who died from drink, yet he never tasted it."

"How could that be?"

"His wife hit him over the head with a bottle of bourbon."

Mark of a Husband

Wife: "I think men should wear something to show they're married. Women wear wedding rings."

Husband: "Men wear something to show they're married—last year's clothes."

Chivalry

Chivalry is a man's inclination to protect a woman from every man but himself.

Didn't Need to Leave!

A woman reported the disappearance of her husband to the police.

"Is there any message you wish to give him if we find him?" the policeman asked.

"Yes," she replied eagerly, "tell him Mother didn't come after all."

Just Half Crazy

"Do you have to keep the women inmates separate from the men?" inquired the visitor at the asylum.

"Sure!" replied the attendant. "These people here ain't as crazy as you think!"

Some Fish!

A man who discovered the joys of fishing rather late in life became even more insistent than ordinary anglers upon recounting his triumphs to skeptical acquaintances. When these friends inferred that he was a liar, he bought a pair of scales, installed them in his library and made his friends watch while he actually weighed his fish.

One evening a neighbor rushed in excitedly to borrow the scales. He was back in 10 minutes, his face flushed with delight. "Congratulate me, boys!" he cried. "I'm the father of a 24-pound baby boy!"

Drill Anyway

The dentist told the millionaire Texas oil man that his teeth were in perfect condition. "But I feel lucky today," pleaded the Texan, "Drill anyway."

Economic Progress

The proud mother walked into the furniture store clutching a small, easy monthly payment in her hand. She placed it on the counter happily. "Here," she said, proudly to the credit manager, "is the last and final installment on that baby carriage."

"That's fine," said the manager, "and how is the baby?"

"Oh," was the proud reply, "He's being discharged from the Air Force next week."

Quite a Change

"Has your wife changed very much since you married her?"

"I'll say—my habits, my friends and my hours."

Occupational Deferment

"We would be pleased," wrote the firm to the Selective Service Board, "if you could assist us in retaining this man a little longer. He is the only man left in the firm, and is carrying on with 15 girls."

Reality

"In the second act," the stage manager said, "you are going to wear another gown. The one you have is too revealing."

"That happens to be the latest style," the leading lady protested. "It cost a fortune and why should I change just to suit you?"

"It's not to please me," the manager explained, "in that dramatic scene when your husband charges 'you are hiding something from me'; well, the audience just laughs."

Not Out Yet

It happened at a marine camp. The troops were lined up for mail call when the sergeant yelled, "Private Benjamin Franklin."

A voice in the rear yelled, "Ye gods, isn't he out on points yet?"

Forced Drunkenness

A disreputable character in court had just admitted being drunk.

"Did you have to drink the whole bottle at one sitting?" demanded His Honor.

"Couldn't help it, Judge," answered the inebriate, "I lost the cork."

Hangover Remedy

Professor: "I won't begin today's lecture until the room settles down."

Voice from rear: "Why not go home and sleep it off?"

Tasty Recipe

Sometimes a pinch of salt can be improved by dropping it into a glass of beer.

Salesmanship

An eager necktie salesman was coming down with a bad cold and laryngitis but still was determined to take advantage of a Saturday when more people were apt to be home. Over his wife's protests, the salesman set forth to knock on doors.

At the first house a beautiful girl clad only in a thin negligee answered his knock. Unable to get his voice above a whisper, the salesman asked, "Is your husband home?" In a real whisper, the girl quickly replied, "No. Come on in."

Slow Race

An elderly gentleman appeared at the betting window of a race track and asked if a horse named Tank Wagon was running in the seventh race. Assured that he was, the man asked about the odds. "Thirty to one," was the reply.

"How many other horses in the race?" he asked.

"Four."

So the old man put a thousand dollars on the horse's nose. Later he came back to inquire on the odds.

"Twenty to one," said the man at the window. "You're the only one to bet on

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60
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New Services • • • New Tools • • • New Methods • • • Outstanding Results

Deep Penetrating M-3 Guns Regularly Used to Perforate Toughest Limestone

McCullough M-3 Bullet Perforators firing improved Ogival Bullets are being used regularly to gain effective penetration in one of the deepest producing fields in Canada.

These wells range in depth from 8900' to 9100'. 5½" O.D. 15.5 lb. or 17 lb. casing is cemented in 9" hole. Producing formation is the tough Mississippian Limestone with variable porosity, much of it below 10%, and with low permeability.

3½" O.D. M-3 Guns are used, firing a uniform pattern of four holes per foot, and resulting in fine producers.

McCullough M-3 Bullet Perforators are called upon again and again to do the toughest jobs. Solid steel gun bodies that give great strength and permit the use of the most powerful perforating powder loads, simultaneous firing that provides a uniform hole pattern and utilizes the full power of the gun on every shot, and improved Ogival Bullets are a few of the reasons why you get deepest penetration.

For best results, call for McCullough M-3 Guns, "hardest shooting bullet perforators in the world."

More power, deeper penetration, simultaneous firing, uniform hole pattern—all combine to get the results you want—MORE OIL! Always specify McCullough M-3 Bullet Perforators.

Solid Steel M-3 Guns Chalk-up Amazing Record Breaker

Powerful McCullough M-3 Guns Fire 9738 Improved Ogival Bullets in One Well—One Job—Rig Time, 117 Hours

McCullough gun perforating crews, using hard shooting, deep penetrating M-3 Bullet Guns, have again broken their record for shooting the most holes in one well on a single job—and turning in a fine producer, to boot!

9738 improved ½" Ogival Burrless Bullets were fired in several pay zones. Total depth was 9510 feet and 7" O.D. 26 lb. and 29 lb. N-80 casing had been cemented through the productive intervals. Guns used were the 4¼" O.D. M-3 Bullet Perforators . . . the world's best!

The well started flowing after perforating began and made 1700 barrels of oil during the job. A blowout preventer had to be used to keep the well under control, indicating the extent of the problems overcome to accomplish this all-time record.

Records like this can only be established by M-3 Bullet Guns; the original solid steel bodied bullet guns that fire all shots at one time and gain deeper penetration than any other bullet gun. These guns save valuable rig time on any perforating job. On jobs over 100 holes the saving is substantial. On this record breaker the operator realized a tremendous saving; McCullough crews fired an average of 83 burrless bullets per hour.

All 9738 bullets shot in this well were improved ogival McCullough Burrless Bullets. The entire perforated zone was scraped on a single run. The scraper came out without a scratch—no damage from burrs or bullets; and the zone washed perfectly!

This entire operation was as smooth as silk—a fine tribute to the skill and efficiency of McCullough gun crews and to the excellent completion program established by the oil company's engineers.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

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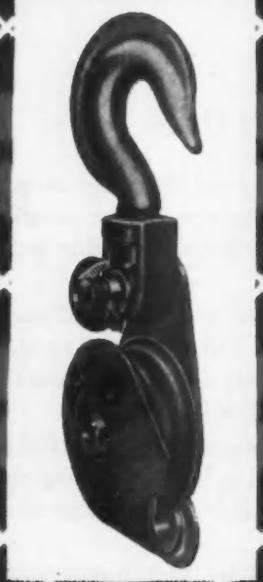
Break in the New Year with a Better Block —



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SNATCH BLOCK
Is quick and safe

Eliminates all lower bolts facilitating easy opening and closing.

Two quick turns of "speed nut" and block is ready to open or close.

"Speed nut" is never completely removed and cannot be lost.

McKissick Builds A Better Block For Every Purpose.

Catalog on Request

McKISSICK
McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

Tank Wagon so far." The old man put another $1000 on his nose.

Close to time for the seventh race, the old man inquired again on the odds. He was advised they were 10 to 1 and that he was still the only bettor on Tank Wagon. When he tried to put another thousand dollars on the horse's nose, the man at the window refused.

"Mister, you're a nice old man and I can't stand to see you lose that much money. I own that horse and I'm not letting him win today."

"Are you sure there are only five horses in that race?" the old man asked.

"I'm positive."

"Then it's going to be a darned slow race," mused the old gent, " 'cause I own the other four."

Wrong Instructions

The young girl was worried as to how her husband would act on their first honeymoon night. Her mother reassured her that all would be fine and gave her instructions: "You arrive in the hotel bedroom, he'll say he's out of cigarettes and disappear. Then you undress and hop into bed."

It happened just that way. They arrived at their room, the husband duly patted his pockets and announced," I'm going to get some cigarettes." When he returned there was his wife tucked up snugly in bed.

"What in the heck are you doing there?" he demanded, "we haven't been down to dinner yet!"

How to Get Your 1956 Editorial Index

A complete editorial index covering all issues of WORLD OIL published during 1956 has been compiled and bound separately in convenient pamphlet form. It will be sent free to all subscribers requesting copies.

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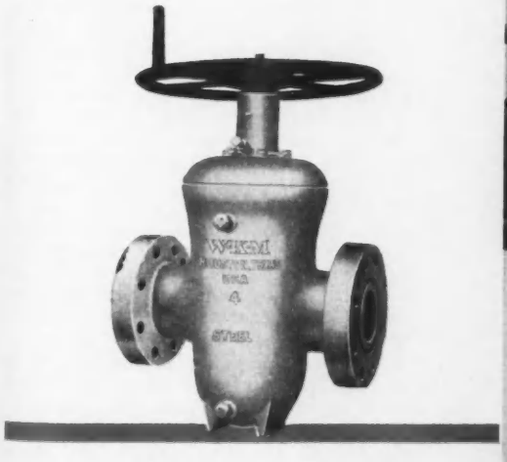
● There's no need to dismantle completely a christmas tree to remove a **W-K-M** Valve for factory overhauling—with the consequent loss of several day's production. **W-K-M** Production Valves can be completely reconditioned right on the tree.

W-K-M VALVES CAN BE OVERHAULED ON THE TREE

to save you valuable time and production

All of the working parts — bonnet, stem and gates — may be removed in one simple operation. Seats can be replaced, if necessary, with **W-K-M** 's hydraulic seating tool. Re-assembly, after thorough cleaning, repairing or replacement of parts, is equally easy. When overhauling is completed your **W-K-M** Valve is as good as new—and usually the job takes only an hour.

For your convenience **W-K-M** servicemen who specialize in this work are available at every active field.



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W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS

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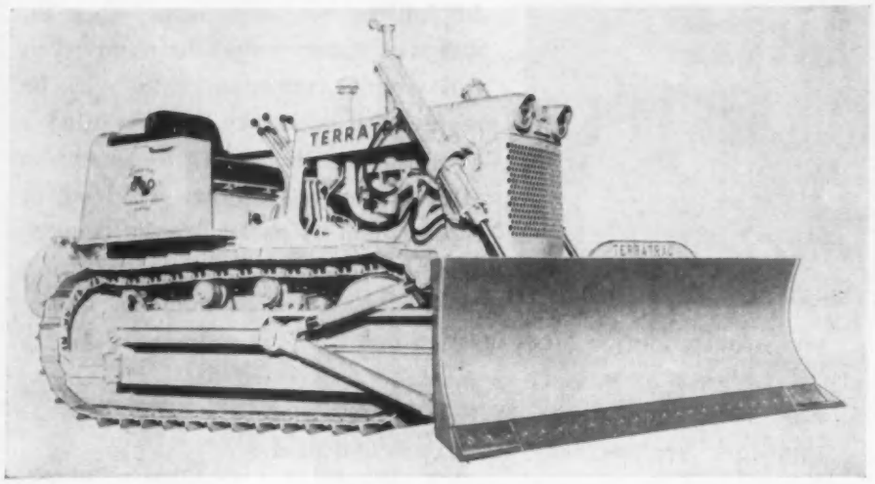
MANUFACTURERS OF W-K-M GATE VALVES ACF LUBRICATED PLUG VALVES KEY-KAST ALLOY STEEL PIPING FITTINGS KEY RETURN BENDS AND FITTINGS

What's New In Equipment

Drilling • Production • Exploration



Wheel and Crawler Line

Included in the new J. I. Case-TerraTrac industrial line of wheel tractors are three separate equipment packages, covering:

1) Industrial utility wheel tractors with matching equipment.

2) Larger light construction wheel and crawler units.

3) Heavy construction and road-building equipment.

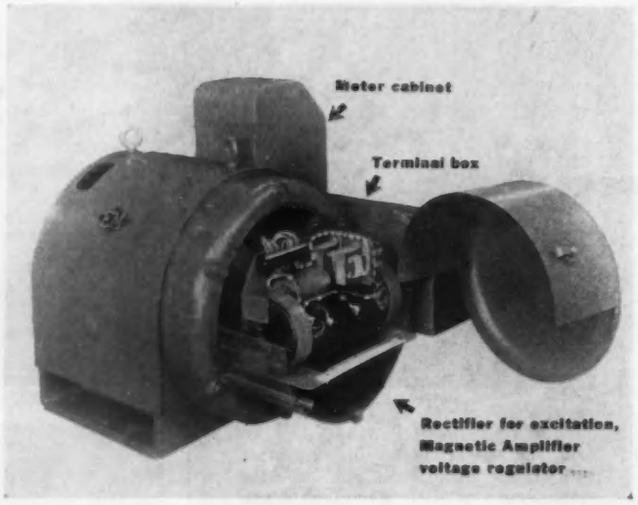
The present Case-TerraTrac industrial line covers 20 gasoline and diesel-powered tractors, ranging from 40 to 80 horsepower in rubber-tired equipment, and up to 100 hp in crawler models.

The new Case industrial rubber-tired tractors and matching equipment have been specifically engineered from the ground up for industrial service, and include such features as drop-forged front axle, power steering, shuttle transmission and foam rubber industrial seat for operator comfort. These wheel units are entirely industrial in appearance, and include heavy-duty bumpers and radiator guards, streamlined recessed headlights and a heavy-duty sub-frame assembly for mounted equipment. The case backhoe for these units incorporates many brand new features, including an exclusive foot-pedal-actuated 180 degree swing, telescopic tubular outrigger extensions, and close-coupled mounting which provides perfect operating balance. The wheel loaders feature 25 degree roll-back and hydraulic leveling—an important new feature for mass-market industrial wheel-loaders.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Static Exciter Generator

The new Amp-Pak packaged generator introduced by Electric Machinery Mfg. Company uses (1) a built-in rectifier for excitation instead of a conventional rotating exciter, and (2) a magnetic amplifier voltage regulator, with no moving parts or vacuum tubes, to provide accurate, quick response voltage regulation.



This entirely static arrangement eliminates much of the maintenance required on conventional synchronous generators. There are no exciter brushes or commutator to maintain. The rectifier, located in the incoming air stream, needs nothing more than occasional blowing out to remove dust. The magnetic amplifier voltage regulator has no vibrating contacts, other moving parts or vacuum tubes, and requires little or no maintenance.

All necessary components of the packaged generator, including the excitation system, voltmeter, ammeter, and voltage adjustment rheostat, are mounted on the generator itself, so that all wiring between the generator and the exciter-regulator components is done at the factory instead of in the field.

Amp-Pak packaged generators are available in three phase ratings of 75-187 kva at 1800 rpm and 62½-187 kva at 1200 rpm. Output voltage may be 120/208 240, 480, or 600. Voltage regulation of ±2 percent is guaranteed.

Packaged generators are widely used with engines for standby and field service. The generator may be single bearing or two bearing coupled, or belted to the engine.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Chemical Fire System

A compact low-cost automatic dry chemical fire extinguishing system for flammable liquid, electrical and textile fire hazards has been developed by Ansul Chemical Company, of Marinette, Wis.

The 30-pound piped system (PS-30) can be operated either automatically or manually. It is intended primarily for protection of moderately-sized hazards, such as paint spray and dip operations, small transformer vaults, heat-treating and oil quench operations, ovens, overhead cranes, stationary engines and textile lint hazards.

The Ansul PS-30 extinguisher consists of a 30-pound capacity dry chemical unit installed near the hazard and serving as a storage tank for the dry chemical. A special CO_2 gas pressure cartridge furnishes pressure to expel the dry chemical onto the fire through piping connecting the dry chemical unit with the hazard area.

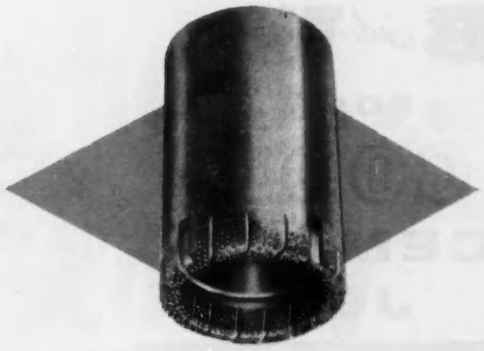
Depending on requirements of the hazard, the system can provide total flooding or local application. Special nozzles are provided to give the most efficient discharge of dry chemical for each type of application.

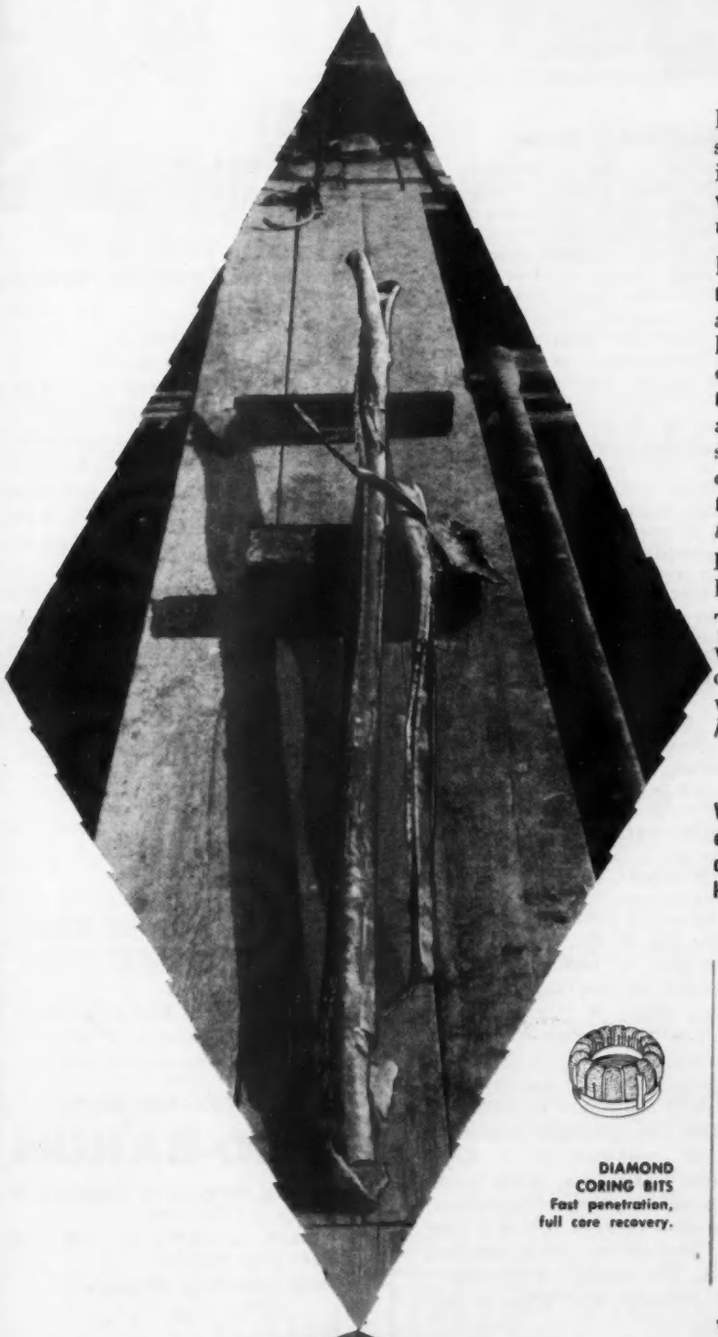
Automatic operation occurs when heat of a fire causes a fusible metal link located above the hazard to part. The impulse is transmitted to the release mechanism located at the dry chemical unit. The release mechanism causes the cartridge to be punctured, pressurizing the extinguisher and forcing its dry chemical charge into the piping leading to the nozzles.

Accessory equipment such as remote manual pull stations and devices for ringing alarm bells, shutting down motors, closing windows and doors, etc., is available. A special bracket is also provided to simplify mounting the equipment and provide easy removal for recharging. The PS-30 can be recharged on the spot and put back into service immediately after a fire.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

D & S washover shoes save time... money!





Drilling & Service Truco diamond washover shoes have performed many extraordinary feats in the oilfield. We cite one example here which tells a graphic story of advantages in using D&S washover shoes for *your* operation:

Recently, one customer had 7" casing set through pay zone. The casing was perforated and a packer set with 2½" tubing. When he started to sandfrac the well, the casing collapsed around the tubing. After backing off the tubing... leaving one joint up for a guide, a 5-15/16" x 4-5/8" D&S diamond washover shoe was run on 5½" OD wash pipe... cutting over the tubing, packer and cutting out the collapsed casing. This was done in *three days' rig time!* When the wash pipe was pulled, the tubing, portion collapsed casing, packer and anchor joint were retrieved inside it.

Total Truco diamond washover shoe cost was only $850. Experience in this type of operation has shown that conventional methods would have required *more* rig time and *higher* related costs.

WRITE OR CALL TODAY! One of our sales engineers will call on you and explain our custom-services and equipment. Herein lie the real D&S advantages.

DIAMOND CORING BITS
Fast penetration, full core recovery.

DIAMOND DRILLING BITS
More footage, less rig time.

DIAMOND WASHOVER SHOES
Fast "Fish" recovery.

CORE BARRELS
The standard of the industry.

TRUCO DIAMOND BITS

Drilling & Service INC. | DIAMOND DRILLING EQUIPMENT

6210 NORTH CENTRAL EXPRESSWAY | DALLAS, TEXAS

OFFICES IN ALL PRINCIPAL OIL AREAS

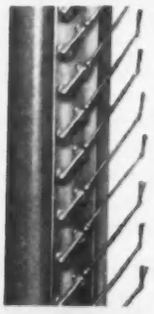
Ultra Fine Diamond Equipment for the Oilfield

B and W Inc.

FOR A

GOOD CEMENT JOB

B & W Hinged Au-Coil Scratcher



B and W Rotating Scratcher — Multi-Flex Type

Movement of Casing...

. . . equipped with B and W Centralizers and Scratchers (reciprocating or rotating), until the plug "bumps," provides the highest percentage of successful cement jobs.

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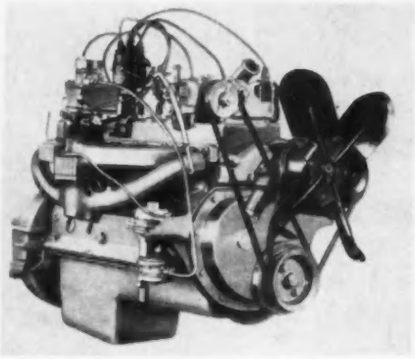

Jeep Industrial Engine

The Industrial Engine Department of Willys Motors, Inc., Toledo, Ohio, has announced development of a new Jeep heavy duty 6-cylinder engine for industrial use. The engine was designed specifically to produce high torque at low speeds. Extra durability has been provided for every engine component which may be subjected to excessive wear. This reinforcement of key points, says Willys engineers, results in an engine of unusual ruggedness.

To test this durability in action, technicians ran repeated 100 hour tests on the new engine at 4000 rpm under full load conditions. These tests were designed to accelerate parts failure and engine wear, as 100 hours of testing or running under the above conditions simulates 50,000 miles of ordinary vehicle travel. During all the tests there were no parts failures or breakdowns of any kind. The engines were disassembled after the tests and inspected carefully. Engineers reported that all components were still in excellent condition.

Valves of the Jeep 6 follow Willys practice of using hard faced stellite or eatonite material, with stellite or eatonite valve inserts and positive rotation for long life, reducing valve warpage, seat distortion and valve burning.

Pistons are of aluminum alloy, each with a control band. This band is cast into the piston around the skirt, avoiding possible collapse of the piston skirt throughout the life of the engine. Possibility of piston slap and high oil consumption are reduced by the control band. Each four ring piston is fitted with full hard chrome top compression ring and a full hard chrome steel rail oil ring.

New premium heavy duty bearings and forged crankshaft contribute to reliability and long engine life. The new crankshaft is 100 percent counterweighted. Completely new manifolding and single barrel carburetion permit economical operation, and a compression ratio of 6.9 to 1 provides greater performance with standard grade of fuels. The engine's performance is said to be virtually impervious to carbon buildup.

With 226 cubic inches displacement, the new heavy duty Jeep provides the following horsepower and torque for continuous duty under full load.

At 1200 rpm's, maximum continuous torque 143, continuous horsepower 33.

At 2600 rpm's, maximum continuous torque 132, continuous horsepower 65.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

M. M. Kinley Company, Licensees

ABILENE, TEXAS
Hudson-Eads, Inc. 2-5551
CORPUS CHRISTI
Tobakut Wireline Services.....5-1811
HOBBS
Horne Well Service Co.....3-5396
MIDLAND
Luccous Service & Equipment Co.....2-1631
PETTUS, TEXAS
Eddie Jones Engineering Co..16 or Beeville 1547
OKLAHOMA CITY
Rainbo Service Co.....ME 4-2131, ME 2-3045
LIBERAL, KANSAS
Rainbo Service .....Main 4-3506
WICHITA FALLS
Hudson-Eads, Inc.....2-3767, 2-8584, 3-4690
CASPER, WYOMING
C. A. White.....3-5264
GLENDIVE, MONTANA
C. A. White.....EMpire 5-3833
FORT MORGAN, COLO.
C. A. White.....919
BEAUMONT, TEXAS
ASEE Co.....TE 5-7046
KILGORE, TEXAS
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WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 3-2731

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in ALL Types of
Internal Combustion Engines
with
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Get proper circulation of water and efficient heat transfer.

Increase lubricating efficiency.

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Gulf Coast District Representatives
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MEADOW BROOK NATIONAL BANK BUILDING
FREEPORT, NEW YORK

Du Pont announces... new HIGH viscosity CMC for drilling muds

Now you can control both fluid loss and viscosity in those areas where *low-solids* muds are commonly used—areas like West Texas and New Mexico.

Du Pont's new *HIGH viscosity* CMC is specifically formulated to meet your need for a low-cost mud additive *which increases viscosity of low-solids muds in addition to reducing water loss.*

Now, with two different viscosity grades, Du Pont CMC for drilling muds is more versatile and useful than ever . . . gives you:

1. Broad viscosity control
2. Low-cost control of fluid loss
3. Thin, tough filter cake
4. Muds of improved stability
5. Improved suspending action
6. Improved emulsifying action
7. Versatile application in a variety of muds

If you are working with low-solids muds, you'll want to try this new HIGH viscosity CMC now. Ask your local mud dealer for it, or contact. . .

- Barada & Page, Inc., offices in Corpus Christi, Dallas, Houston, Kansas City, New Orleans, Odessa, Oklahoma City, Tulsa, Wichita.
- Macco Corp., Paramount, California.
- Du Pont Explosives Department offices in Dallas, Texas, Los Angeles, California, or Wilmington, Delaware.

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• MAGNETIC FISHING TOOLS
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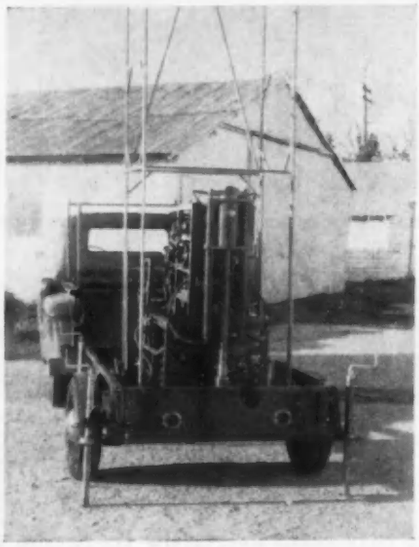
DRILLING



Hydraulic Core Drill

The new ADCO 1000 hydraulic core drill, with four-speed transmission, is a portable unit for low-cost shallow oil or mineral exploration, water well and soil test drilling, developed by Allied Drilling Company, Houston.

Already field-proven in uranium exploration in the western states, where several discoveries have been made, this drill is powered with a 2-cylinder TFD 14 horsepower Wisconsin engine, with self-starter and magneto, for drilling to 1000 feet, or may be used with a 30 hp engine for drilling to 3500-foot depths.

Capable of drilling up to 3-inch diameter holes with diamond core, insert or roller type bits, on 1 5/16-inch standard "E" rod, with controlled hydraulic down-pressures from 0-1500 pounds and 28-inch stroke, the unit is of all-steel construction, with heavy-duty hydraulic valve controlling speed and direction. It is equipped with easy to reach controls, adjustable relief valves and necessary gages.

The fully directional drill head, of precision-machined cold-rolled steel, is driven by steel spiral miter gears, with extra heavy-duty ball bearings throughout.

Capable of air drilling, using a 60 to 125 cubic foot compressor, or water-mud drilling, with heavy-duty simplex pump and recirculating slush tank, the drill weighs approximately 1000 pounds and is commonly skid-mounted for easy portability, or may be permanently truck-mounted, depending on individual requirements.

With a square type hoisting tower, which easily handles 20-25 foot sections of pipe, the drill can be operated on the ground or from the pick-up.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Crown Block Protection

A patented new device offers a simple solution to one of drilling's biggest problems, crown block protection. Called the Crown-O-Matic Protector, it prevents costly accidents caused by running into the derrick crown and is adaptable to all makes of rigs. It can be adjusted, controlled and reset quickly and economically at derrick-floor level. A special actuator mounted on the drawworks automatically shuts down operation when drilling line turns on the drawworks drum reach a predetermined number, the number necessary to bring pipe and hoisting apparatus to the danger point.

The Crown-O-Matic makes crown-protecting devices at inaccessible locations high on the derrick unnecessary. It is distributed exclusively in the Gulf Coast area by Stewart & Stevenson Distributing Company.

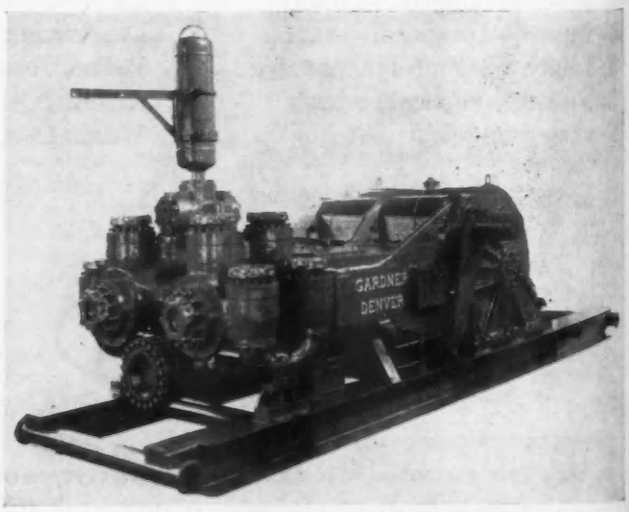
(This item supplements Stewart & Stevenson Distributing Co. data on pages 4768-4769 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

1250 H. P. Mud Pump

The addition of a new 1250 horsepower mud pump to its line is announced by Gardner-Denver Company. Known as the GH-GXH, the new model is designed with an 18-inch stroke for heavy-duty drilling service.

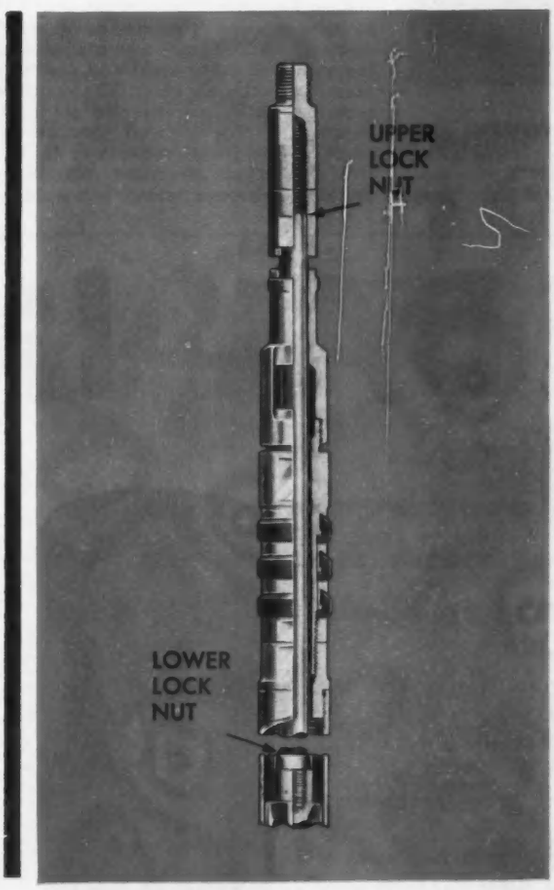
The master size liner is 7¾-inch, which may be reduced through five liner sizes to 6 inches. The GXH delivers from 884 gpm at 2060 pounds per square inch, using master 7¾ inch liners, to 500 gpm at 3642 psi with 6 inch liner. Hydrostatic tests at 9000 psi on discharge and at 4500 psi on suction prove ample working pressure ratings of 4500 psi on discharge and 2250 psi on suction.



For more data, circle **No. E7** on Readers' Service Card, last page this issue.

VALVE ROD LOCK NUTS *Exclusive* ON D+B PUMPS

eliminate expensive fishing jobs...



UPPER LOCK NUT PREVENTS BREAKAGE OF VALVE ROD AND ELIMINATES UNSCREWING!

LOWER LOCK NUT ALSO PREVENTS VALVE ROD BREAKAGE AND ALLOWS A MEANS OF REMOVING PUMP WITH THE ROD STRING.

No matter what your subsurface pumping problem, you will find a D+B precision-built pump will meet your needs. Superior performance and proven design spell longer pump life and low maintenance. Prompt pump shop service is available when and where you need it from Continental-Emsco D+B Pump Shops and field men in all major producing areas.

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P-702

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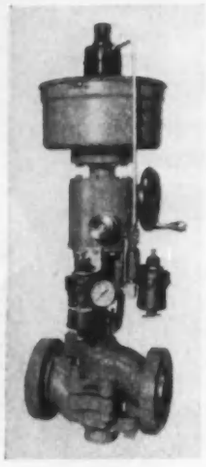
and 2250 psi on suction.

Service Card, last page this issue.

PRODUCTION

Handwheel Operator

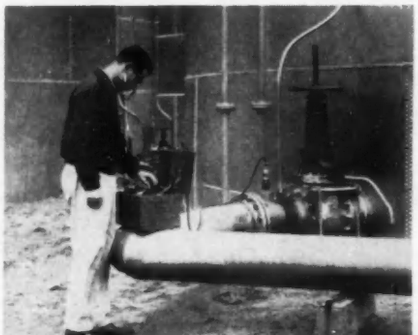
The Cono-Clutch handwheel operator is available from Conoflow Corporation as an integrally mounted accessory for the company's standard line of Cylinder Conomotor actuators. The Cylinder Conomotor, a pneumatically positioned power actuator, has found wide industrial application for throttling control on numerous types of valves, motor driven speed changers, proportioning pumps, flow regulators, rheostats, autotransformers, etc.



The Cono-Clutch hand operator affords immediate manual control in the event of air failure. It is the only operator of its type which can be instantly thrown in and out of gear at any position of the stem travel. Clutching and declutching are accomplished simply by pulling or pushing a knob conveniently located on the face of the unit. No special tools such as pins, latching devices, hand cranks, etc., are required. When the handwheel is in declutch position, there is absolutely no interference with full and free stem travel.

The unit presents a compact, streamlined appearance; it has no protruding levers, brackets or extensions. All gears are enclosed in a sturdy, lightweight aluminum housing, eliminating the possibility of dust and grit clogging the gear mechanism. Alemite fittings are easily accessible for gear lubrication.

For more data, circle **No. E8** on Readers' Service Card, last page this issue.



Pipe Corrosion Measure

Developed by Crest Instrument Company of Santa Fe Springs, Calif., the Corrosometer, measures electrically the progress of corrosion in any corrosive system. It is used in conjunction with special probes containing metal specimens which are subject to corrosion. Probes of more than 30 metals and alloys are available. These are supplied in a number of designs to meet the varying pressure and temperature conditions of different systems.

Three models of the meter are manufactured: the Model "C," which is a completely portable field unit operated by batteries; the Model "K," which is designed for laboratory use and in plants where A.C. is readily available; and the Model "R," which is a continuous recording unit designed to give a visual reading as corrosion takes place.

In use, the Corrosometer follows the progress of corrosion on the probe by measuring the loss of metal directly in microinches of penetration into the metal. The measurement is based on the increase in electrical resistance of a metal as corrosion takes place. Readings are made independent of temperature by comparing the resistance of the exposed metal specimen to that of a similar specimen also built within the probe, but which is protected from the corrosive medium by a suitable coating.

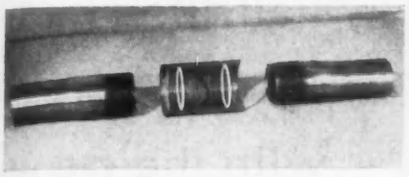
The Corrosometer method has several advantages over other means of corrosion measurement. These advantages include the ability to make rapid and direct measurements with only about 30 seconds being required for a reading. No shutdown is needed to retrieve metal specimens inasmuch as the probe remains in the corrosive system at all times. The time to establish corrosion rates is measured in

DAY IN

LARKIN LEADERSHIP HAS BEEN EARNED

hours or days rather than weeks or months because of the high sensitivity of measurement. With the most sensitive probes, one-tenth of a microinch of corrosion can be detected. Measurements can be made in systems not easily accessible because several hundred feet of cable can be used between probe location and meter. Only the Corrosometer method permits measurement of both uninhibited and inhibited corrosion rates on the same metal specimen without removing the metal from its environment.

For more data, circle **No. E9** on Readers' Service Card, last page this issue.



Pipe Coupling Seals

A new concept in oil field tubular goods connections is the GT-API coupling seal which is being produced and marketed by the Hardy-Griffin Engineering Corporation of Houston. This seal can be used in all types of pipe connections.

In recent tests conducted by R. R. Crookston & Associates, Houston consulting engineers, the seals of the 2⅜ inch and 2⅞ inch sizes withstood hydrostatic tests to 13,000 and 12,000 psi, respectively, and 100 cycles of thermal shock gas testing at temperatures ranging from approximately 95° to 180° F. and pressure ranging from approximately 9600 to 10,000 psi for the 2⅜ inch size and 8600 to 10,000 psi for the 2⅞ inch.

The thermal shock gas testing procedure was devised to accelerate the effects of alternate well flow and shut-in conditions and that gas, even though more dangerous, is used to betray possible leaks because of its low viscosity compared to fluids.

The GT-API coupling seal employs Teflon, a super tough plastic made by the DuPont Company. Teflon is not affected by any acid or fluid and it resists temperatures up to 585° F. according to DuPont. The Teflon seal in Hardy-Griffin tubing joints, because of its confining design, will withstand any pressures encountered with modern drilling methods.

In addition to the advantage of providing leak-proof joints for new strings of tubing and pipe, the Hardy-Griffin method can be used to make old tubing and pipe hold pressure. The GT-API sealed coupling is easily adapted to gas and water lines.

For more data, circle **No. E10** on Readers' Service Card, last page this issue.

Portable Pump Jack Bases

A new product recently developed by Byers Portobase, Inc., is a full line of

universal portable concrete pump jack bases. These universal bases, made without anchor bolts and using a center tie down method, are manufactured in a complete range of sizes that will take almost any pump jack.

A big advantage of the universal base is that each base will take any one of several different units thereby enabling the various dealers to cover the full line of units with a very few bases. The universal base is supplied either with engine slide rails, for use with the stub base pumping units, or without the slide rails for use with the extended base pumping units. The universal base, by being adaptable to any one of several different pumping units can be cast well in advance of orders insuring complete curing of the concrete before delivery.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

— AND DAY OUT

wells everywhere are safely and successfully cemented with Larkin Equipment

The preponderant use of Larkin Floating and Guiding Equipment is a natural result of its years of dependable performance. Experience brings confidence — and that's why thousands upon thousands of wells each year are cemented through Larkin Equipment.

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So SIMPLE that "Specials" are Likely to be Standard!

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol

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Because of the utter simplicity of Magnetrol's magnetic operating principle, standard models can be easily adapted to meet any special requirements for pressure, temperature or corrosive liquids . . . and usually at little extra cost. This Magnetrol versatility has solved all kinds of tough level control problems . . . and given our engineers wide application experience that can be invaluable to you.

Magnetrol is so simple that failure is all but impossible! Using only permanent, unfailing magnetic force for its operation, there's nothing to wear out . . . no diaphragms or bellows to stiffen and rupture . . . no electrodes to short or corrode . . . no packing to bind or leak. Magnetrol is practically maintenance-free! Magnetrol units are available for controlling level changes from .0025-in. to 150-ft. . . . with multi-stage switching when desired. Send coupon for full details.

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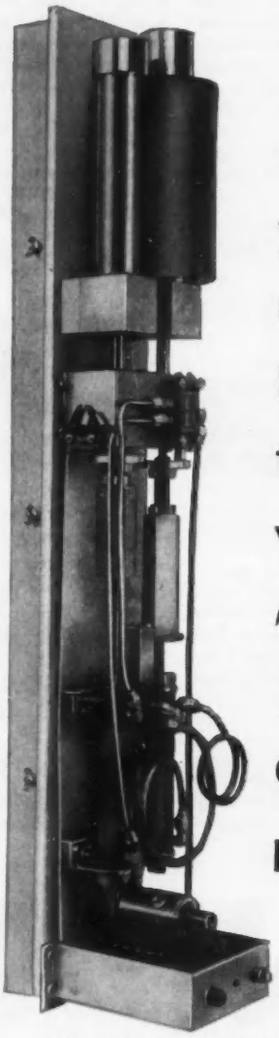

now you **can** use a short half-life tracer with the **new**

Tracerlab

Gamma Milker

Tracerlab's new Cs^{137} — Ba^{137} Gamma Milker is a compact system for injecting the 2.6 minute half-life Barium^{137} into pressurized systems for precise flow measuring and tracing operations *without any danger of permanent contamination of the material under study.*

And this unique Gamma Milker offers another big advantage . . . the Cs^{137} produces its "daughter" isotope, Ba^{137} constantly. Thus you are sure of as many as 20 "shots" before the Cesium cartridge needs replacing.

For full information on the new Tracerlab Cs^{137} — Ba^{137} Cartridge for short half-life isotope work, write for Bulletin No. 84.

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New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Turbopower Diesel Booklet

A well-illustrated brochure describing General Motors Turbopower Diesels has been issued by the Detroit Diesel Engine Division. Specifications of industrial and marine models ranging from 159 to 300 brake horsepower are fully described along with features of design and performance data.

To get a copy, circle **No. E12** on Readers' Service Card, last page this issue.

Micro-Profile Calipers

Birdwell Micro-Profile Calipers and their uses in profiling oil and gas wells are presented in Bulletin B-2027 by Birdwell Surveys, Bradford, Penn.

Nine ways of using the improved 3-arm caliper with three sets of controllable arms of different length are given. Extreme details of automatically recorded profiles are illustrated. Locations of field stations are included.

To get a copy, circle **No. E13** on Readers' Service Card, last page this issue.

Guiberson Catalog

The Guiberson Corporation, one of the Dresser Industries, announces a new enlarged catalog for the years 1957 and 1958, containing full descriptions, detailed engineering data, complete parts price lists and numerous illustrations of Guiberson oilfield equipment.

The 160-page catalog is strongly bound and printed throughout in large readable type on good heavy paper. Copy is confined to essential information and every listed item is priced and identified by individual part number. Exploded parts drawings assist in quick identification of replacement parts.

Setting and removal procedures are clearly outlined and a surface setting stroke table provided for each type of packer offered. The catalog is useable, readable, accurate and complete.

To get a copy, circle **No. E14** on Readers' Service Card, last page this issue.

V-Belt Drive Manual

To all users of V-belt drives as well as to V-drive designers, the new Maurey 66-page V-belt drive engineering manual will prove a ready and complete source of needed information. The manual is organized to provide quickly the facts and figures wanted by the production man, the engineer and the designer. It is divided into three general sections. The first section, entitled "V-Drive Selection," is devoted to Drive Service Factors, Instructions on How to Select a Stock Drive, and complete V-belt drive tables for A, B, C, D and E section V-belts.

The drive design section lists drive service factors, and provides how to design instructions and data. Subjects covered are Finding Required Horsepower of the Drive, Proper Belt Selection, Determination of Speed Ratio, Selection of Sheave Diameters, Determination of Belt Speed, Figuring Number of Belts Required, Finding the Right Belt Length or Center Distance, Providing Proper Take-Up Allowance, etc., for V-V, V-Flat and Quarter-Turn Drives. Complete tables in this section provide horsepower ratings of A, B, C, D and E section V-belts.

The General Information section provides further data and facts of interest to the V-drive user and designer.

To get a copy, circle **No. E15** on Readers' Service Card, last page this issue.

Grant Tool Booklet

Grant Oil Tool Company made available for the first time at the Permian Basin Oil Show in Odessa a new, copyrighted booklet entitled "How To Avoid Crooked Hole and Control Deviation." The handy pocket size booklet includes a number of easy to follow illustrations which answer the following questions:

1. Without increasing deviation, how much more weight can be carried by using a stabilizer? 2. To change the hole angle or drill a new hole with a reduced angle in the same formation, what combination of stabilizer and drill collars should be used? 3. What combination of drill collars and stabilizers must be used when reducing hole in order not to exceed the deviation of the larger hole in the reduced hole?

The booklet contains tables of weights and stabilizer distances from the bit which have been excerpted from American Petroleum Institute reports on hole deviation.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Grommet V-belt Bulletin

Construction features of the "Texrope" grommet V-belt which provide 20 to 50 percent longer life than ordinary belts are described in a new bulletin released by Allis-Chalmers Manufacturing Company.

According to the bulletin, the "Texrope" grommet V-belt has one-tenth the shrinkage, one-third the stretch, runs cooler, and grips better than the ordinary belt.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Pumping Unit Bulletin

Crank counter-balanced pumping units having an API beam load rating of 24,000 pounds and peak torque of 228,000 inch-pounds are presented in Bulletin No. 462 by National Supply Company, Pittsburgh.

This 8-page bulletin covers design, construction, and specifications of the National Type E-24, largest of a line of six basic Type E units, and one of 12 basic sizes of National pumping units with 18 standard specifications in beam and crank counter-balanced types.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Engine Case Histories

The first four of a new series of engine case histories have been published by the Le Roi Division, Westinghouse Air Brake Co., Milwaukee, Wis. The case histories cover the entire line of Le Roi engines, ranging from 75 to 675 horsepower.

The two-page case histories use pictures and drawings to illustrate applications using Le Roi V-8 and V-12 engines of 540 to 4000 cu. in. size.

Applications described in the first four histories include those of air conditioning, gas boosting, cotton ginning, and irrigation.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Wire Line Service Booklet

Great Lakes Petroleum Services, Inc., has available a new "fortune-size" 16-page color brochure describing in detail their Wire Line Services. Included is a brief history of GLPS, and completely illustrated sections on their advanced equipment and services—the 7/16" line perforating truck, the 3/16" line thru-tubing perforating truck and accessory equipment, Gamma Ray-Neutron logging instrumentation, gun perforators, jet perforators, and other wire line services.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Diesel Engine Data

Available from Maschinenfabrik Augsburg-Nurnberg is a 16-page data booklet on M.A.N. diesel engines specifically for oil well drilling. The booklet gives detailed specifications on the line of six and eight cylinder diesel engines available with or without supercharging in ranges from 170 to 440 horsepower. All units may be converted from diesel to natural gas fuel as required.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

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